16 DECEMBER 1955

ONE SHILLING & SIXPENCE

FLIGHT

and

AIRCRAFT ENGINEER

OFFICIAL ORGAN OF THE ROYAL AERO CLUB

WESTLAND

is the Hallmark of British

HELICOPTERS

WESTLAND AIRCRAFT LIMITED · YEOVIL · ENGLAND

THREE NAVIGATORS

Every member of the crew is well acquainted with instruments bearing the two famous names of Kelvin and Hughes. The navigator who has worked on British pressurised aircraft will have met the neat Kelvin Hughes periscopic sextant which is designed to eliminate the need for the astro-dome and astro compass. When he wishes to take a bearing, up goes the periscope to project three inches outside the fuselage. When he has finished, down it comes again to make a smooth external fuselage line—and no cabin pressure has been lost. A good navigator, plus Kelvin Hughes, unquestionably make a first-class team.

We shall be pleased to provide you with further facts on the Periscopic Sextant or any other of our instruments in which you may be interested.

KELVIN HUGHES

HELPING THE WORLD TO FLY

KH

KELVIN & HUGHES (AVIATION) LTD., BARKINGSIDE & BASINGSTOKE

KHA 59

Sole Sales Concessionaires:

SMITHS AIRCRAFT INSTRUMENTS LIMITED

CRICKLEWOOD, LONDON, N.W.2, ENGLAND · TELEPHONE: GLADSTONE 3333 · TELEGRAMS: AIRSPEED, TELEX, LONDON

Can you get out of this maze?

This one's easy — but when it comes to designing the right kind of springs and presswork for a specific job, then you may be only too glad to have us help you out. We've been designing and manufacturing springs and presswork for close on a century; turning them out by the million; and as accurately as if we were watch-makers! The "know-how" now at our finger tips is quite amazing — and it is freely at your service.

TERRY'S ***SPRINGS & PRESSWORK***

HERBERT TERRY & SONS LTD. REDDITCH. ENGLAND

A

Around the World

Airlines Order U. S. Jet Transports

Commercial aviation moved toward the new jet air age recently with the announcement by several U.S. airlines of the purchase of Boeing 707 or Douglas DC-8 jet transports to go into service between 1958 and 1960.

As this is being written Pan American World Airways has ordered 20 Boeing 707s and 25 Douglas DC-8s, while United Airlines has bought 30 Douglas DC-8s. American Airlines has ordered 30 Boeing 707s and National Airlines has announced the purchase of 6 Douglas DC-8s. Braniff International Airways and Eastern Air Lines have said they will purchase quantities of either Boeing or Douglas jets, and similar announcements by several other major airlines are expected soon.

The new jet airliners, to be faster and larger than any other transports now offered by any other manufacturer in the world, will cruise at more than 550 m.p.h. and will be able to carry well over a hundred passengers. They will fly non-stop from New York to Paris in 6½ hours.

Four turbojet engines will power each transport. Two models of Pratt & Whitney Aircraft engines are being ordered, the J-57 rated at 10,000-pounds of thrust, and another twin spool, axial flow engine of even greater power. The J-57 engine has been in service since 1953 on the fastest U.S. military aircraft.

DOUGLAS DC-8 jet airliner is newest in world-famed series of Douglas transports. The DC-3, also known as the Dakota, was the most widely used transport of airlines all over the world. Many major airlines, both in the U.S. and in Europe, now fly Douglas DC-4s, DC-6s and DC-7s. The new DC-8 will use four Pratt & Whitney Aircraft turbojet engines.

with United Aircraft

BOEING 707 jet airliner has been flying for more than a year in prototype form. Boeing has built more large jet aircraft than any other manufacturer, including the huge B-52 for the U.S. Air Force, which also uses Pratt & Whitney Aircraft jet engines. Both the Boeing and the Douglas will set new standards of performance in commercial air travel.

NEW HELICOPTER FLEET of 7 large Sikorsky 12-passenger S-58s has been ordered by New York Airways. The new helicopters will go into service in 1956, augmenting the airline's present fleet of 5 Sikorsky S-55s. A spokesman for Sabena Belgian World Airlines has announced that his company is also considering the early purchase of a quantity of Sikorsky S-58s. Other countries are also discussing acquisition of the new helicopters.

WATER, SNOW, SAND OR ICE operations are possible for this ground-based U.S. Air Force C-123 transport with special water-ski landing gear. Hamilton Standard reversible propellers give a braking action and provide unusual flexibility in ground and water handling. This version of the C-123 was designed by Stroukoff Aircraft Corporation, New Jersey.

UNITED AIRCRAFT EXPORT CORPORATION *East Hartford 8, Conn., U. S. A.*

European Offices: 3/5 Warwick House Street, London SW1, England

PRATT & WHITNEY AIRCRAFT *Aircraft Engines*

HAMILTON STANDARD *Propellers and Jet Aircraft Equipment*

SIKORSKY AIRCRAFT *Helicopters*

DUAL VOLTAGE at the *turn* of this switch

The illustration shows our type G.S.7. ground power unit. It incorporates a 6-cylinder ROLLS-ROYCE engine driving our specially developed dual voltage generator. The engine and generator are unit mounted making for compactness and perfect alignment. Two separate output cables are provided giving either 28 volts or 112 volts as required. The change-over is made by means of one small selector switch mounted on the control panel. All the most advanced protective devices are incorporated, to safeguard the aircraft and generating sets completely.

(PATENTS APPLIED FOR)

★ Although weighing only 37 cwts. this set has proved easily capable of starting the largest jet and turbine engines at either 28 or 112 volts. A 40 kw. continuous output is also available for aircraft servicing.

(FULL SPECIFICATION AVAILABLE ON REQUEST)

VERNONS INDUSTRIES LTD

VERNONS INDUSTRIES LTD · VALLEY ROAD · BIDSTON · BIRKENHEAD. *Phone:* B'HEAD 6416

This is the complete Vickers propeller-turbine family. The new Vickers 900, with the Viscount 700 and 800 series, will provide operators with a fully integrated fleet, carrying passengers in superb comfort over all routes from the shortest to 2,500 miles.

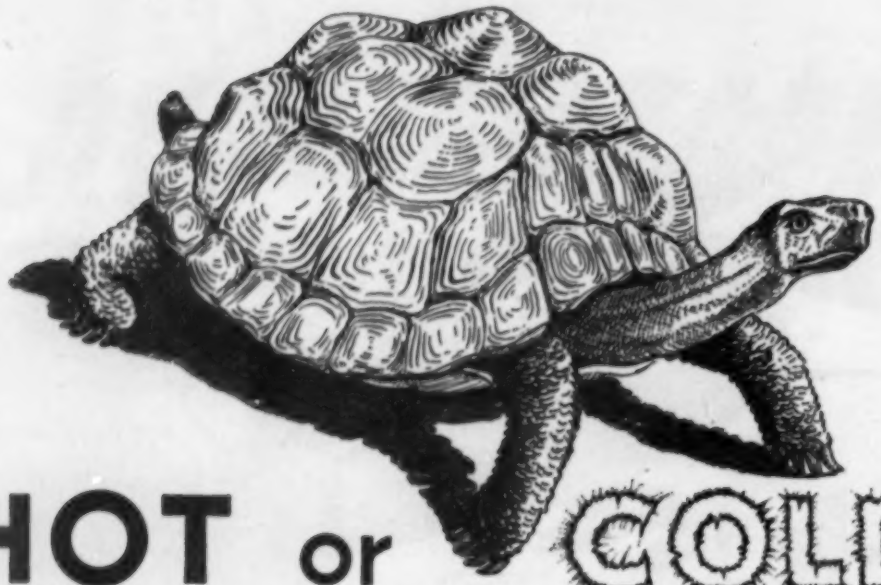
A plane of pedigree...

VICKERS 900

FOUR ROLLS-ROYCE TYNE PROPELLER-TURBINE ENGINES

VICKERS - ARMSTRONGS (AIRCRAFT) LIMITED · WEYBRIDGE · SURREY

TGA AT 451



HOT or COLD

The tortoise with his stout shell is a well protected creature, but he's vulnerable to extreme heat and cold. His problem is, being a cold blooded animal, nature has not provided him with any means of temperature control.

HAVE YOU A TEMPERATURE PROBLEM?

It pays to consult

B·A·P

who specialise in the manufacture of

LIGHTWEIGHT HIGH-TEMPERATURE INSULATION BLANKETS

for the AIRCRAFT GAS TURBINE AND JET ENGINE INDUSTRY. With a range of blankets covering round surfaces such as JET PIPES and pre-formed types for double curvatures and other complex shapes, suitable for temperatures up to 1000° C.

TAILOR MADE TO YOUR REQUIREMENTS

Let us have your enquiries for Development and Production

BURNLEY AIRCRAFT PRODUCTS LTD.

FULLEDGE WORKS, BURNLEY, LANCS., ENGLAND

STONYHOLME WORKS, GROSVENOR STREET, BURNLEY

Telephone : 3121/2 and 3203 BURNLEY *Telegrams* : "AIRCRAFT" BURNLEY

ASSOCIATED WITH: RENFREW AIRCRAFT AND ENGINEERING CO., LTD. RENFREW, ONTARIO, CANADA

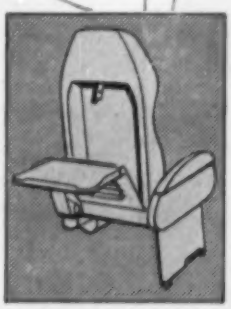
NEW AIRCRAFT SEAT—BY *Shorts*

The problem of the speedy conversion of a passenger airliner for carrying freight has now been solved. In association with British European Airways, Shorts have developed a seat which will be fitted to BEA's new Viscount 802 fleet (although suitable for many other aircraft) which has every feature for passenger comfort and, at the same time, meets the new Air Registration Board requirements. It can be folded to one side simply and quickly to permit the carriage of freight without sacrifice of passenger comfort or increase in weight. The new Shorts seat gives airline operators the passenger/freight flexibility which they need for economical running.

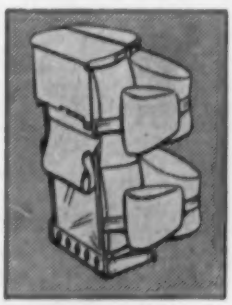
If you have an aircraft seat problem Shorts can solve it for you

Adjustable back, of course. Centre arm rest also movable. Fits snugly into back of seat.

Side of seat can be adjusted outward for extra roominess.



Tray table fixed independently of seat in front.



Folding the seats to one side is a simple matter. No tools needed.

SHORT BROTHERS & HARLAND LTD., QUEENS ISLAND, BELFAST, N. IRELAND. *The first manufacturers of aircraft in the world*

GIVE THE BEST FOR CHRISTMAS—

STATE EXPRESS 555

Christmas Gifts and State Express—to many they are synonymous. Over the years Christmas gift packings of State Express cigarettes have been relied on to solve the problem of presents for friends and family. Within this season's range there is an appropriate choice for every purpose.

BY APPOINTMENT TO HER MAJESTY THE QUEEN
STATE EXPRESS
CIGARETTE MANUFACTURERS
ARDATH TOBACCO CO. LTD.

ENGLISH PEWTER TANKARDS

Made in Sheffield in hammered finish, with the traditional glass base, and containing an airtight tin of 50 State Express 555 cigarettes.

½ pt. Tankard 27/6
1 pt. Tankard 37/6

GREETINGS PACKINGS OF STATE EXPRESS 555

In colourful outers with a picturesque illustration of seasonable character.

50 State Express 555 cigarettes ... 10/-
100 State Express 555 cigarettes ... 20/-

PRESENTATION CABINET

Styled in the traditional State Express 555 manner, this Cabinet in Primrose and Gold contains

150 State Express 555 cigarettes ... 30/-

STATE EXPRESS 555

The Best Cigarettes in the World

The House of STATE EXPRESS 210 PICCADILLY LONDON W.1

GYRON-SPECTRE

for the

MIXED-POWER-PLANT FORMULA

The **GYRON**
a most powerful axial jet engine designed to a formula embracing all the features which are indispensable for supersonic flight.

The **SPECTRE**
a liquid-propellent rocket engine developing its maximum power at altitudes beyond the scope of air-breathing engines.

DH ENGINES

THE DE HAVILLAND ENGINE COMPANY LIMITED

ALLOY STEEL CASTINGS & FORGINGS

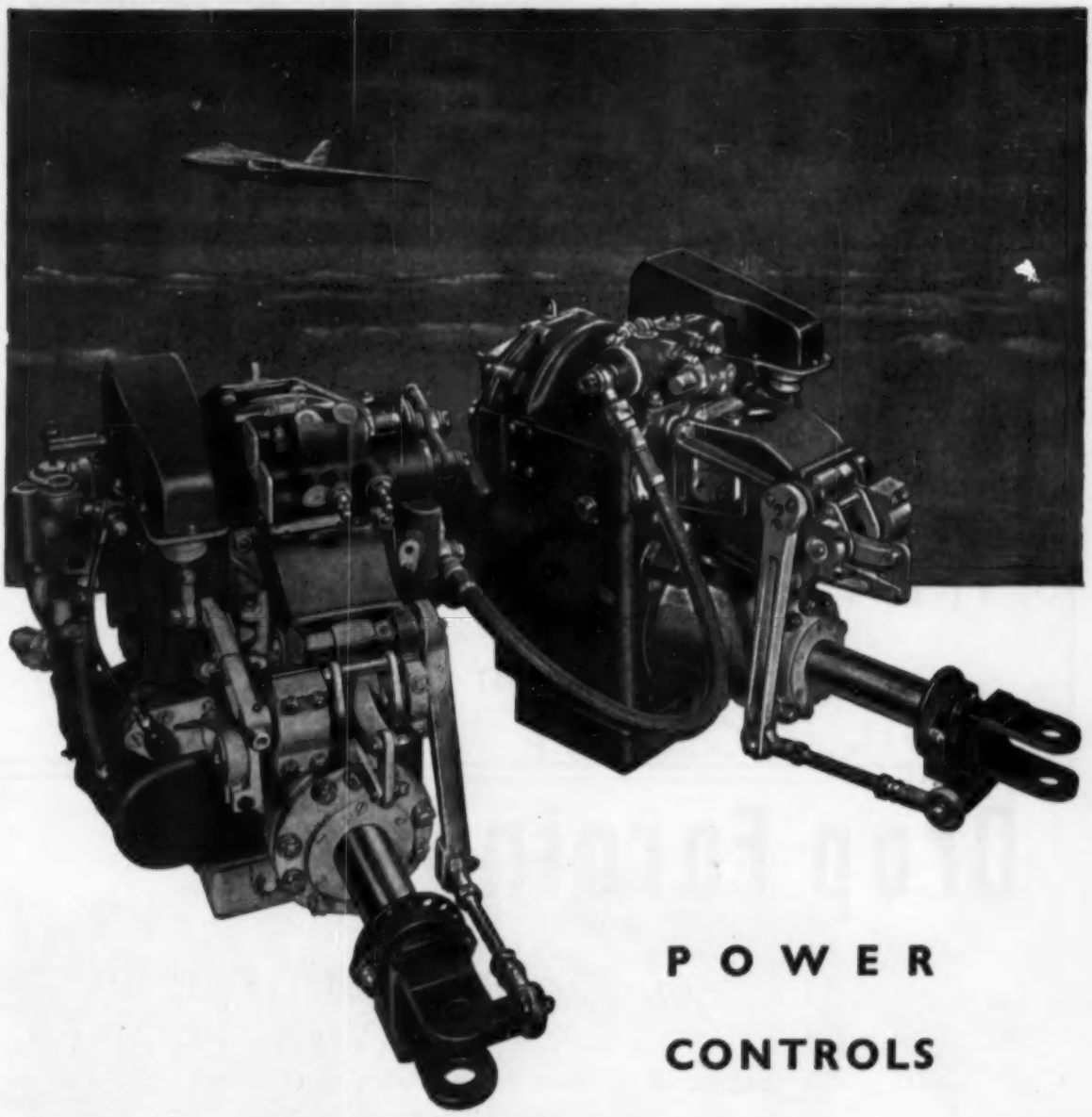
Hadfields produce castings and forgings for aircraft in a wide range of alloy steels. Their foundries, which comprise a large conventional foundry, precision casting and shell moulding units, are A.I.D. approved for castings to D.T.D. 666 and 705.

Class I components include sand castings, precision castings by the lost wax and shell moulding processes, turbine disc and compressor wheel forgings, etc.

Compressor wheel for 'Avon' engine, by courtesy of Messrs. Rolls-Royce, Ltd.

HADFIELDS SHEFFIELD

HADFIELDS LTD., EAST HECLA WORKS, SHEFFIELD, ENGLAND.



POWER CONTROLS

BOULTON PAUL power controls are characterised by their *SENSITIVITY*, independent of aerodynamic loads; *FIDELITY* of response under all normal conditions of loading and rates of operation; *STABILITY*, inherent in the design; *PRECISION* in manufacture and performance; *SAFETY*, positively ensured by duplication of fundamental components; *RELIABILITY*, proved by a long history of trouble-free service; and *VERSATILITY*, enabling the system to be applied in widely varying arrangements to suit the requirements of individual aircraft designs. The dual unit illustrated operates the rudder of the Avro Vulcan bomber.

BOULTON PAUL AIRCRAFT LTD

WOLVERHAMPTON, ENGLAND

P.C.9.

ROLLS-ROYCE

IN THEIR FINEST ENGINES INSTALL

NOZZLE GUIDE VANES

MANUFACTURED BY

H & F PRECISE CASTINGS LTD.

DERBY

Drop Forgings

for the ROLLS-ROYCE AVON

The unsurpassed quality of the Rolls-Royce Avon engine is supplemented by the **150** different precision forgings manufactured by:—

ARTHUR ROBINSON & SONS (WILLENHALL) LTD

Registered Office and Works

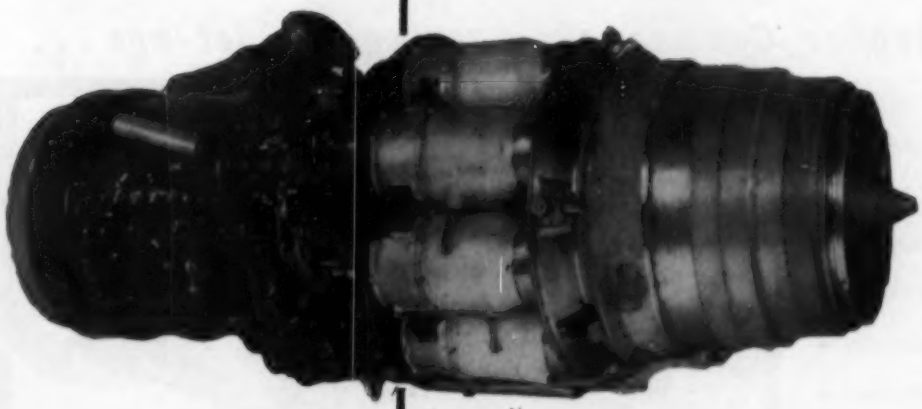
GIPSY LANE **WILLENHALL** STAFFS

CARLISLE

STAINLESS STEELS

CARLISLE STAINLESS AND HEAT RESISTING STEELS ARE SUPPLIED REGULARLY TO

ROLLS-ROYCE



AND ARE EMPLOYED IN THE

'AVON'

C. G. CARLISLE & CO., LTD.
IONA STEELWORKS, PENISTONE ROAD, SHEFFIELD
TELEPHONE: SHEFFIELD 48791 (3l1 nes) TELEGRAMS: NICHROME, SHEFFIELD

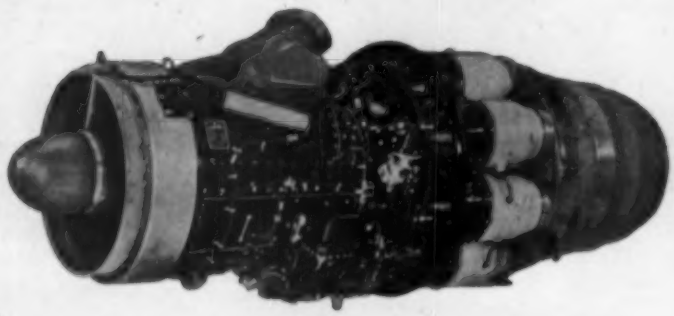
Suppliers, without break, of Aircraft Engine Forgings to Messrs Rolls Royce for 40 Years

The Hughes-Johnson Stampings Ltd
Langley Green, Birmingham

PR

Rubber Components Serving the jet-age . . .

- SEALS
- 'O' RINGS
- DIAPHRAGMS
- BONDED PARTS
- MOULDINGS
- EXTRUSIONS



ROLLS-ROYCE AVON
TURBO-JET ENGINE

The superlative performances of the AVON and other aircraft engines designed and produced by Rolls-Royce Limited demand the most exacting materials, manufacture and workmanship.

Precision Rubbers Ltd., are proud to enjoy the confidence of Rolls-Royce in the selection of **P.R.** rubber mouldings for incorporation in their aircraft engines.

PRECISION RUBBERS LTD · BAGWORTH · LEICESTER · Phone: BAGWORTH 241/2/3
APPROVED A.I.D. AND A.R.B.

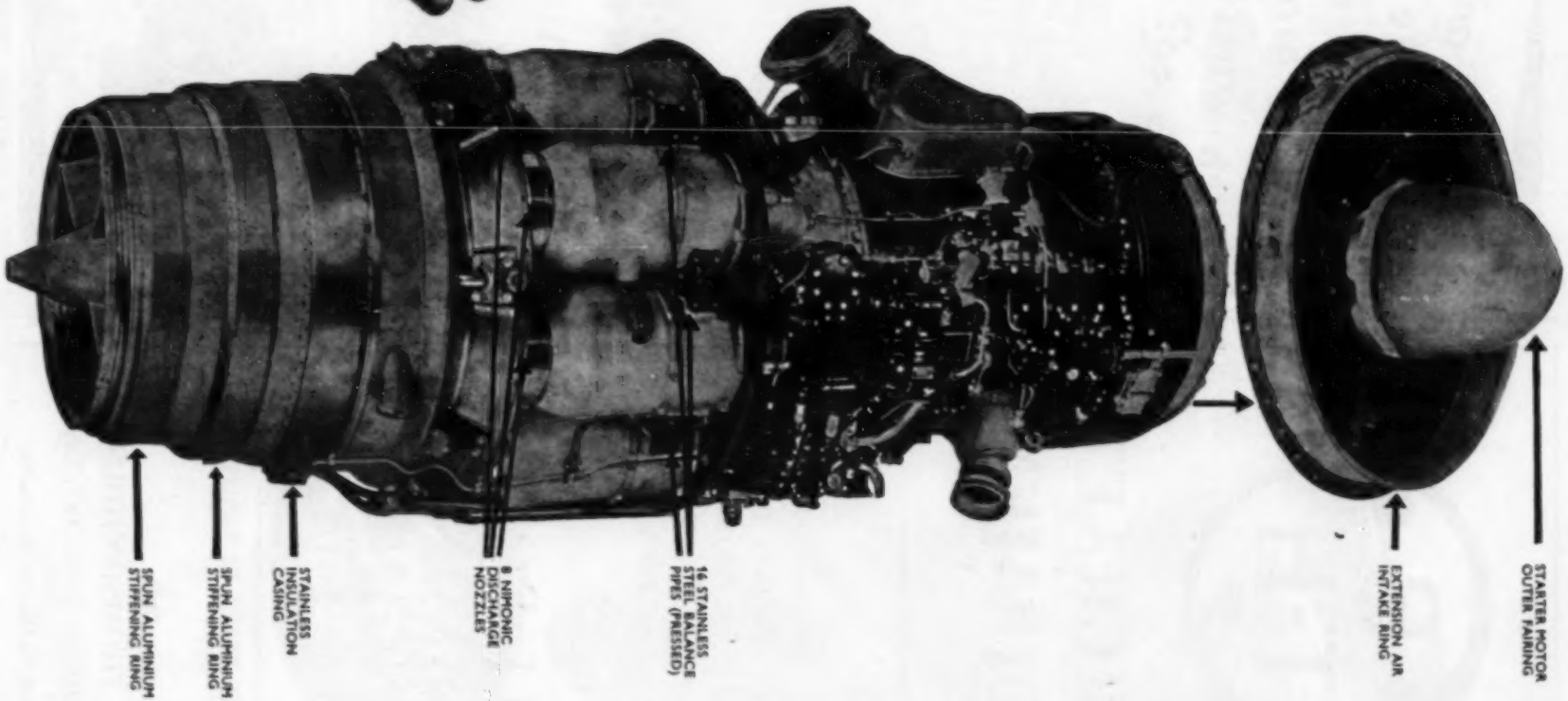
Specialists in Precision Mouldings in Natural, Synthetic and Silicone Rubbers to officially approved specifications and to customers specific requirements

TELEPHONE: SHEFFIELD
24228 24229 24220
TELEGRAMS: BRAMAH
24228 SHEFFIELD

ESTABLISHED
1844

NIPHONIC DISCHARGE NOZZLES

J.R. Bramah & Co. Ltd.
OF
Sheffield
HEAD OFFICE
DEVONSHIRE ST., SHEFFIELD, 3


SPUN ALUMINIUM STIFFENING RING
SPUN ALUMINIUM STIFFENING RING
STAINLESS INSULATION CASING
8 NIPHONIC DISCHARGE NOZZLES
16 STAINLESS STEEL BALANCE PIPES (PRESSED)
EXTENSION AIR INTAKE RING
STARTER MOTOR OUTER FAIRING

The manufacturers of "AVON" Jet engine details

Also Specialists in the manipulation and welding of
"TITANIUM" in the form of Spinnings, Pressings & Fabrications

B T-H

AIRCRAFT EQUIPMENT

British Thomson-Houston are proud that their products, including turbo-starters and high-energy ignition units, are contributing to the success of the

ROLL-ROYCE "AVON" ENGINES

THE
BRITISH THOMSON-HOUSTON
COMPANY, LIMITED, COVENTRY, ENGLAND

Member of the AEI group of companies

A4975N

—will any of these solve any of those Fluid Control problems with which you are faced?

1. Ultra light and compact electrically operated Spherical Plug Cocks (2 new models).
2. High Pressure Axi-flow Cock for handling Nitrogen at 4,000 p.s.i.
3. Spherical Plug Cock for handling fuel at 2,000 p.s.i.
4. Hot Air Non-Return Valve to D.A.R.D. Specification.
5. Large Bore Spherical Plug Cock for use in hot air systems up to 250°C.

SAUNDERS VALVE

For the **SAFE** *handling of all Aircraft Fluids*

SAUNDERS VALVE COMPANY LIMITED
Aircraft Division
BLACKFRIARS STREET, HEREFORD

for *Fire* safety

in the air...

and on airfields—install

'Pyrene' fire detecting and fire extinguishing equipment is contributing to the greater safety of modern air travel. 'Pyrene' Smoke and Fire Detecting Systems in aircraft give instant warning of fire and operate in conjunction with 'Pyrene' Fire Extinguishing Equipment to ensure immediate action in emergency.

For ground duty, there are various forms of hand appliances and portable and mobile fire-fighting units using Special Liquids (including Chlorobromomethane), CO_2 Gas, Dry Chemical or Foam. There is a wide range of fire-fighting vehicles and mobile equipment designed to meet all fire dangers on every class of airfield including crash fires and 'starting-up' fires.

If you are concerned with any aspect of fire safety, it is important that you should know about the latest 'Pyrene' fire safety developments. For details write to Dept. F.L.12

Pyrene TRADE MARK FIRE SAFETY EQUIPMENT

AN INVESTMENT IN PEACE OF MIND

THE PYRENE COMPANY LTD

9 GROSVENOR GARDENS · LONDON S.W.1 *Tel:* VICtoria 3401

Head Office and Works: BRENTFORD · MIDDLESEX *Canadian Plant:* TORONTO

C

THE DOOR FOR THE JET AGE!

Fitted with aluminium alloy shutter leaves, double skinned for insulation, and top hung for unfailing ease of operation, these new Bolton Patent Hangar Doors are so perfectly balanced that a 1 h.p. motor operates them with ease, and are built to any size to your requirements. 20 ft. high and 90 ft. wide, the door illustrated is opened in 90 seconds, bunching to 8 ft. in width. If you would like a demonstration—drop us a line! As a first step, send for the Bolton Hangar Door Leaflet and our general Catalogue FB8.

BOLTON TOP HUNG HANGAR DOORS

BOLTON GATE COMPANY LIMITED · BOLTON · LANCASHIRE

dm BG183

Capacity for

very large

. . . jigs and fixtures
. . . aircraft components

Our Machine Shops are laid out for
EXPERIMENTAL MACHINING
DEVELOPMENT WORK
PRODUCTION—LONG OR SHORT RUNS

We can work to the finest limits on the
FINEST MACHINE TOOLS

Fully A.I.D. approved Ref. No. 79367/2/58.

Reasonable prices. Prompt deliveries.

Send your enquiries to:

Leytonstone JIG & TOOL Co. Ltd.

LEYTOOL WORKS, HIGH ROAD, LEYTON, LONDON, E.10 *Telephone: Leytonstone 5022-3-4*

THE FERRANTI PEGASUS COMPUTER

The Ferranti Pegasus Computer installed at the London Computer Centre, 21 Portland Place, W.1.

The Ferranti Pegasus Computer is a new high-speed general-purpose electronic digital computer of exceptional versatility. It is particularly suited to the calculations arising in the Aircraft and Engineering Industries.

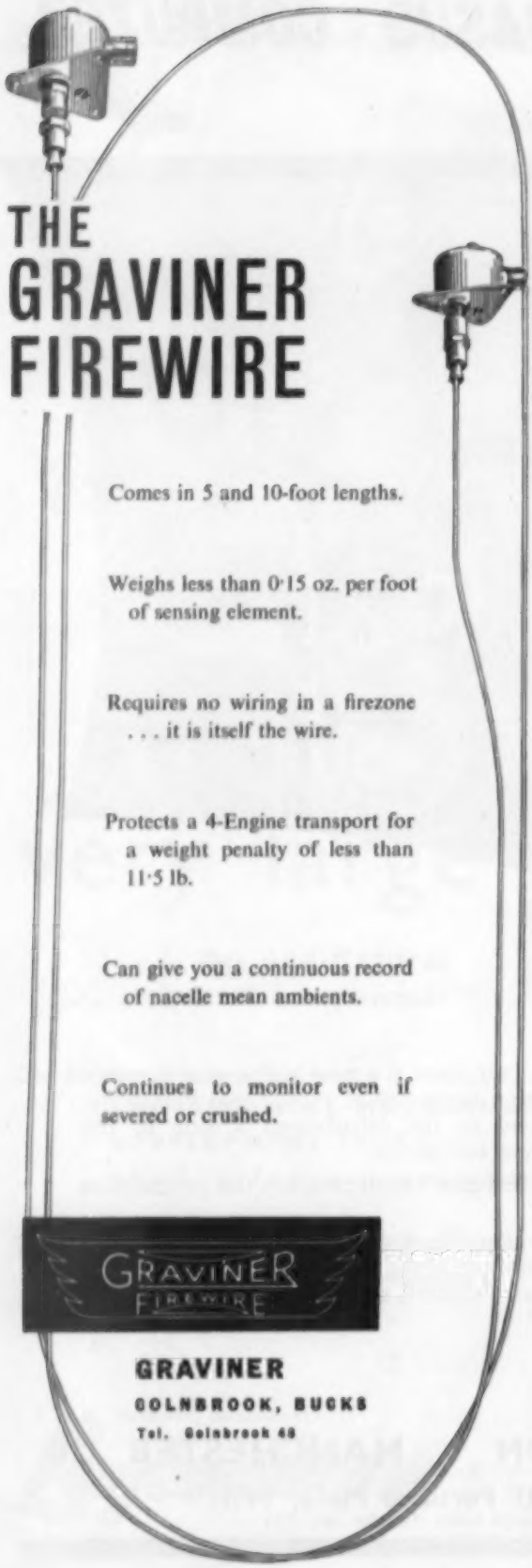
It incorporates many features which simplify the preparation of work for it.

For lists giving details of applications of Pegasus in the Aircraft Industry, write to Computer Department, Moston, Manchester 10, or London Computer Centre, 21 Portland Place, London W.1.

FERRANTI LTD · MOSTON · MANCHESTER 10

London Computer Centre: 21 Portland Place, W.1.

DC22



THE GRAVINER FIREWIRE

Comes in 5 and 10-foot lengths.

Weighs less than 0·15 oz. per foot of sensing element.

Requires no wiring in a firezone . . . it is itself the wire.

Protects a 4-Engine transport for a weight penalty of less than 11·5 lb.

Can give you a continuous record of nacelle mean ambients.

Continues to monitor even if severed or crushed.

GRAVINER FIREWIRE

GRAVINER
COLNBROOK, BUCKS
Tel. Colnbrook 48

What is this Russian Aircraft?

If you want to know everything about

RUSSIAN AVIATION

★ In the December 15 issue of France's leading (and biggest circulation) weekly, "AVIATION MAGAZINE" will proudly present the first instalment of the most ambitious and all-embracing survey of contemporary and historical aviation in Russia.

★ The series will draw on a pool of more than 1,600 rare photos, drawings and silhouettes. Many will be published for the first time in Western Europe.

★ Internationally known experts have spent TEN YEARS in basic research alone, to make this authoritative series possible.

ALL DATA WILL BE GIVEN IN METRIC AND ENGLISH MEASURES—A SHORT SUMMARY IN ENGLISH WILL HELP OUR ENGLISH READERS.

order now

Your copy or subscription via:

Librairie Française
127, Regent Street, LONDON

SPECIAL FREE OFFER

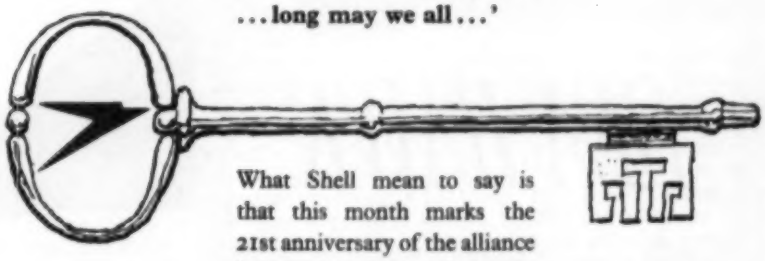
To every reader of FLIGHT, "Aviation Magazine" offers, on receipt of your letter, a free copy dealing with Russian aviation. All you have to do is to cut out this advertisement and send it with your name and address to:

AVIATION *Magazine*

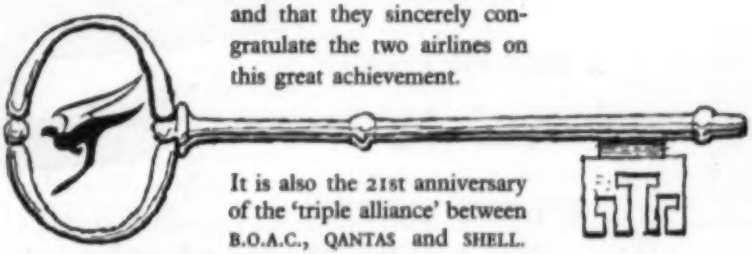
124, rue Réaumur - PARIS, FRANCE

TWENTY-FIRST BIRTHDAY OF A 'TRIPLE ALLIANCE'

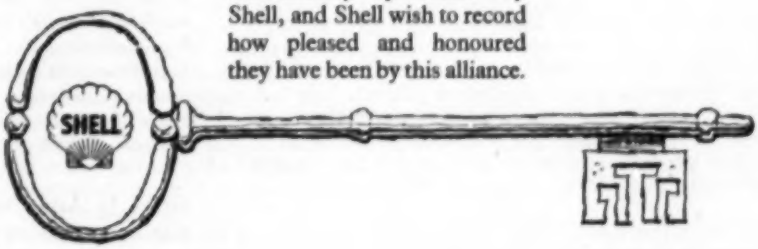
'Shell extend . . . Shell wish their old friends . . . B.O.A.C. and QANTAS . . . England and Australia . . . links which will not easily be broken . . . long may you . . . long may we all . . .'



What Shell mean to say is that this month marks the 21st anniversary of the alliance between B.O.A.C. and QANTAS in operating the air service between England and Australia, and that they sincerely congratulate the two airlines on this great achievement.



It is also the 21st anniversary of the 'triple alliance' between B.O.A.C., QANTAS and SHELL. Throughout this time the aviation fuels and lubricants for the two airlines have been continuously provided by Shell, and Shell wish to record how pleased and honoured they have been by this alliance.



The Fleet Air Arm packs a bigger punch now that the Sea Hawk is in squadron service. Easy to handle, easy to land on deck, the Sea Hawk is the most efficient carrier-borne fighter in the air today. In addition to production for the Royal Navy the Sea Hawk is also backed by large American off-shore dollar orders. This key aircraft, which combines exceptional manœuvrability with tremendous fire power, is the perfect fighter for the jet-age Navy.

SEA HAWK

PACKS A BIGGER PUNCH FOR THE JET-AGE NAVY!

GENERAL DATA

High-speed Naval jet-fighter with folding wings: mid-wing monoplane of stressed skin all-metal construction with tricycle undercarriage. The air-intakes for the single engine are placed in 'nostril' formation at the wing roots. The Hawker patented bifurcated outlet trunk enables the exhaust to discharge from the trailing edge instead of from the fuselage tail end. This allows more room for inbuilt fuel tanks to provide greater range. Span — 39 ft. Length — 40 ft. Maximum speed — close to speed of sound. Power — one Rolls-Royce 'Nene' turbo-jet.

Sir W. G. Armstrong Whitworth Aircraft Ltd.
Baginton, Coventry

MEMBER OF THE HAWKER SIDDELEY GROUP
PIONEER... AND WORLD LEADER IN AVIATION

FIRST AERONAUTICAL WEEKLY IN THE WORLD FOUNDED 1909

FLIGHT
and
AIRCRAFT ENGINEER

No 2447 Vol 68 FRIDAY 16 DECEMBER 1955

Editor
MAURICE A. SMITH D.F.C. and BAR

Associate Editor
H. F. KING M.B.E.

Technical Editor
W. T. GUNSTON

Production Editor
ROY CASEY

Iliffe and Sons Ltd
Dorset House
Stamford Street
London, S.E.1
Telephone · Waterloo 3333 (60 lines)

BRANCH OFFICES

Coventry
8-10 Corporation Street
Telephone · Coventry 5210

Birmingham 2
King Edward House, New Street
Telephone · Midland 7191 (7 lines)

Manchester 3
260 Deansgate
Telephone · Blackfriars 4412 (3 lines)
Deansgate 3595 (2 lines)

Glasgow C.2
26a Renfield Street
Telephone · Central 1265 (2 lines)

Toronto 2, Ontario
74 College Street
Telephone · Walnut 4-5361

New York 6, N.Y.
111 Broadway
Telephone · Digby 9-1197

SUBSCRIPTION RATES
Home and Overseas · Twelve Months, £4 10s. U.S.A. and Canada, $14.00

In this issue

890 Agricultural Double
893 Background to Strasbourg
895 The Felixstowe Flying Boats—Part 2
900 Rolls-Royce Avon
907 Commercial Programme
909 Free-flight High-speed Research—Part II
912 The Aeronautical Bookshelf
915 Miles M.100 Student

A By-pass Wooing

HIGH in the headlines, along with the resurgent Comet, has been a British aero engine—possibly the first occasion on which a piece of ironmongery (as George Edwards of Vickers would describe it) has been raised to such lofty dignity.

The elevation was most certainly merited, for the engine concerned was the Rolls-Royce Conway by-pass turbojet, now left forlornly with no V.1000 to power. True, a trial installation is to be made in a Vulcan or Victor medium bomber; but, though a Conway-Comet is an appealing possibility, prospects of very widespread application in this country are remote, with the result that American interest has been further stimulated. Negotiations, indeed, have reached the point where Rolls-Royce representatives have visited the Boeing Airplane Company and a spokesman of that company has declared, "The power of the Conway is such that it would fit very nicely into our 707 jet transport."

We have long been aware, of course, that in the gentle art of spotting a good thing our friends at Boeing are eminently well-practised. When, at Philadelphia this year, we ourselves had the pleasure of telling the afore-mentioned spokesman that the Conway's diameter was no more than the Avon's, in spite of the by-pass duct, his interest warmed to the point where the conversational thermometer hit the security mark. Since that meeting his company has become aware that a Conway has been type-tested at a rating of 13,000 lb. They know, too, that significantly higher outputs were in prospect for the V.1000, and will even yet be available to the persevering jet-transport constructor; and sounding sweetly in their ears is a phrase uttered by the chief engineer of the aero division of Rolls-Royce: "The pod is God's gift to the by-pass engine."

Should this almost dove-like courtship lead ultimately to a happy union (and there are high hopes of it, for American engine-makers have nothing to offer in the Conway class), it might promote a far broader alliance.

Orpheus the Charmer

Nor is the Conway the only British turbojet to command public attention in recent days, for the significance of the new Bristol/Fiat agreement did not pass unmarked. Under its terms the great-hearted little Orpheus will be installed in Fiat-built G.91s for NATO, and the Italian company will have an option to manufacture it under licence.

The G.91, however, is only one (albeit the principal) of three types of light fighter/attack machines—all Orpheus-powered—now being built for a NATO trials programme. Implicit in the NATO tactical-support philosophy is the necessity to produce the aircraft and their engines internationally, and in large numbers, as an integrated programme. To meet the requirement for large-scale production of the engines proposals have been submitted to NATO for the Orpheus to be built under the aegis of a production group, headed by Bristol.

This sounds like big business and calls for the warmest congratulations to the Bristol company, though, as this year's Paris Show disclosed, French engine-builders are offering a challenge with their new small turbojets of about half Orpheus thust, intended for dual installations. The Orpheus, too, is the heart of the Folland Gnat, hope for which is by no means extinguished, especially so as the Indian Government has now formally announced that it is considering a proposal to build the Gnat in the Hindustan Aircraft factory.

Not in America—nor, so far as can be learned, in any other country—is there an engine to match the Orpheus; and that lustrous successors are already in contemplation, if not in view, is implied by the disclosure that the Fiat agreement covers engines developed from it.

Add to the Conway and Orpheus the Tyne, the latest Avons and Soars, the Eland, Gazelle and Oryx, the Gyron and Gyron Junior, the advanced Sapphires (not forgetting the Spectre and Screamer rockets), and the way ahead may well prove to be paved with foreign currency.

FROM ALL QUARTERS

Royal Inauguration of L.A.P.

ACCOMPANIED by H.R.H. the Duke of Edinburgh, Her Majesty the Queen is due to arrive at London Airport at 2.55 p.m. today to inaugurate the new central-area terminal buildings. After an official welcome by the Lord Lieutenant of Middlesex and Mr. John Boyd-Carpenter, Minister of Transport and Civil Aviation, Her Majesty is due to inspect the guard of honour outside the eastern apex building. The inaugural ceremony is expected to take place in the exhibition hall of this building at 3.5 p.m., with the unveiling by Her Majesty of a plaque commemorating the occasion. Following an inspection of the passenger building, where the Royal party will see the nurseries and a baggage conveyor in motion, and will meet Customs, immigration, port health and other airport officials, the tour is due to end with a private visit to the control tower.

Variable Wing Section

WINGS suitable for one flight regime are not necessarily the optimum for another. Variable incidence, variable sweep, variable span and variable area have all been tried, but until recently there have not been any full-scale tests of variable section. (In stating this we exclude the work of pioneers of the pre-1910 era, who frequently employed variable profiles, and we also discount the use of flaps and slats.) Nevertheless, variable section is a potent formula, and it is now being examined in a Republic F-84F.

This aircraft has been fitted with inflatable rubber strips along the entire leading edge and forward part of the under-surface. In high-speed flight these strips lie flat, but they can be inflated by compressed air—either by the pilot, at any speed, or automatically as speed is reduced—so resulting in a significant increase in radius of curvature at the leading edge and a reduction in the inclination of the flow to break away at high angles of attack.

Flight-testing has so far indicated a reduction in take-off speed of some 17 m.p.h. (ten per cent) and in landing speed of 23 m.p.h. (15 per cent). Translated into runway requirements the rubber-winged F-84F needs roughly one-fifth less room to take off and one-third less for landing. The installation was by Goodrich.

Flight Refuelling at 21

IN a glowing "family" atmosphere 700-odd employees and guests of Flight Refuelling, Ltd., celebrated the company's 21st anniversary at Bournemouth last Friday. Lady Cobham presented pewter, silver and gold tankards for periods of service of 10, 15 and 20 years (a number of the old hands collected all three), and Sir Alan reminisced and looked ahead in a sparkling address.

Of this occasion and of other matters concerning the fast-growing business of "F.R." we shall be saying more next week.

—and Flight Refueling A-16

MEANWHILE, from America it is learned that Flight Refueling, Inc., of Baltimore, have developed a high-capacity refuelling unit for the probe and drogue system, having a rate of flow "several times that of the hose-reel refuelling unit now in production." Designated A-16, the new unit has been developed to meet "requirements of the new jet tankers to be used for refuelling high-speed jet bombers and fighters." Flight tests are imminent.

"Flight" photograph

MINISTER AMONG THE PILOTS: The annual cocktail party of the British Air Line Pilots' Association, held this year on December 7th, provides an opportunity for informal discussion between pilots and other members of the air-transport world. The Minister of Transport and Civil Aviation, Mr. J. A. Boyd-Carpenter (left), is seen with the association's chairman, Capt. A. Spooner; in the background is Mr. D. Follows, secretary of B.A.L.P.A. (Other pictures, p. 919.)

Glenn L. Martin

AS briefly recorded last week, Mr. Glenn L. Martin died at Baltimore on December 4th.

Glenn Luther Martin was born at Macksburg, Iowa, on January 17th, 1886. As a boy he set up a production line of box kites in his mother's kitchen, price 25 cents a kite. He took a degree in business economics at Kansas Wesleyan University and secured work successively in a bicycle shop and an automobile business. After a few months he started his own garage and, on a glider of his own making, took up gliding from the hills near Santa Ana. Soon he rented an abandoned church wherein he built an aeroplane which, after two years' work and at an expenditure of $2,000, was ready to fly. The first flight (100ft distance at 2ft altitude) was on August 1st, 1909.

By November 1910 he was giving exhibition flights and was soon making an appreciable income. One two-day exhibition, for instance, swelled his bank roll by $750. During 1911 he was barnstorming all over the west. From Newport Bay, near Los Angeles, on May 10th, 1912, he flew a Martin seaplane 38 miles to Catalina Island and back. He is thought to have been the first man to deliver mail and newspapers by air, or to bomb a mock fort. He used his machine to hunt coyotes, to track a convict and to pick up a passenger from a boat; he is said to have been the first airman to fly his own mother, the first to take motion pictures from an aircraft, and the first to shower the public with department-store advertising matter.

In 1912 he moved his factory to Los Angeles and started a flying school, and in 1913 he built a four-passenger seaplane. A bomb-sight and automatic-opening parachute were among his inventions at about this time. He joined with the Wright brothers to form a new company, but with this his association was short-lived. In January 1918 he was authorized to proceed with the building of large bombers at Cleveland, and when his backers relinquished their interest he became sole owner. By 1929 business was such that it was necessary to move it to a 1,200-acre site 12 miles from Baltimore, and from the new plant such historic machines as the China Clipper flying-boat and the B-10 monoplane bomber emerged. Prominent among Martin types of recent years have been the Baltimore, Maryland, Marauder and B-51 bombers; and the Mariner, Marlin, Mars and SeaMaster flying-boats.

It is the more sad, in recording the death of a great airman and designer, to have to record also the loss last week of one of the prototype Martin SeaMasters in a crash at the mouth of the Potomac River.

TECHNICAL COLLABORATION: The scene at the signing of the Bristol/Fiat agreement (referred to in a leading article), which concerns the installation of the Orpheus in the Fiat G-91 and subsequent technical collaboration. NATO orders have been so far placed for 72 Orpheus engines and Fiat have received complementary orders for thirty G-91 fighter/attack aircraft.

Signing, in this picture, are Sir Reginald Verdon Smith, Bristol chairman, and Fiat's managing director and general manager, Ing. Gadenzio Bono. Second from left is Ing. Guiseppe Gabrielli, managing director of Fiat's Aircraft Division, and on the extreme right G/C. M. Pinfold, British Air Attaché in Italy. Next to G/C. Pinfold are Maj. W. T. C. Rogerson, Bristol representative in Italy, and Mr. F. C. Marchant, chief designer (turbines) of Bristol Aero-Engines, Ltd.

***OPENING A GATEWAY:** The formal inauguration of the new central buildings at London Airport is due to be performed today, December 16th, by H.M. the Queen. The control tower and the short-haul passenger terminal are now in full use, and the eastern apex building—on extreme right in this "Aerofilms" view—is externally complete.*

Beverley in Canada

THE Blackburn and General Aircraft Beverley XB 262 arrived in Canada last week-end for its winterization trials after an uneventful and consistent journey from Brough, *via* Prestwick, Keflavik and Goose Bay. The flying times for the two trans-atlantic legs were 5 hr 30 min and 10 hr 35 min respectively. From Goose Bay onward to Montreal was completed in 4 hr 10 min, from Montreal to Ottawa in 40 min, Ottawa to Toronto in 1 hr 45 min, Toronto to Winnipeg 5 hr 25 min and Winnipeg to Edmonton 4 hr 45 min. The total distance flown from Brough to Toronto was 5,500 miles.

After giving demonstrations at Toronto, Ottawa and Montreal the Beverley—which is the one that carried out tropical trials in North Africa last August—will go to the Central Experimental and Proving Establishment R.C.A.F. Station Rockliffe, whose Climatic Detachment will supervise the cold-weather trials. The aircraft will be evaluated under near-Arctic conditions in terms of servicing, maintenance, functioning of systems, ease of engine starting and certain performance characteristics.

In addition to a crew of 18, the Beverley carried on its outward flight some 13,000 lb of spares and equipment, including a complete Centaurus engine. The crew was a mixed one of R.C.A.F. personnel and English civilian technicians. The captain was S/L. R. H. Janson, with F/L. D. W. Walkey as second pilot and F/O. C. A. Jarvis as navigator.

Mr. G. C. Trowbridge

WE learn with regret that Mr. George C. Trowbridge, M.I.M.E., M.I.P.E., managing director of Wickman, Ltd., until February 1954, died on November 28th. Mr. Trowbridge joined the company as deputy managing director in 1944, becoming managing director in 1947. He was a well-known production engineer, and between the wars was for many years production manager of the Gramophone Company, of Hayes. In 1936 he became general manager of the Speke (Liverpool) factory of Rootes Securities, Aircraft Division, but relinquished this position in 1942 to assume the managing directorship of Powderloys, Ltd., of Coventry, a Wickman-associated company.

His retirement from business in 1954 was caused through ill-health, for which he was undergoing treatment at the time of his death. He was 67 years of age.

AT THE E.T.P.S. DINNER

ON Thursday of last week the McKenna Dinner was held at the Empire Test Pilots' School, marking the completion of No. 14 course. All the heads of the companies' flight-test departments were there, with the exception of "Bill" Pegg of Bristols, "Ben" Gunn of Boulton Paul, and John Cunningham of de Havilland Aircraft; and, of course, there were the usual distinguished guests from the Ministry of Supply and elsewhere, including Air Chief Marshal Sir John Baker, Controller of Aircraft, M.o.S.; Rear-Admiral W. T. Couchman, Deputy Controller of Aircraft; A.V-M. W. A. Opie, Assistant Controller of Aircraft; Mr. Handel Davies, Scientific Adviser to the Air Ministry; A. Cdre. Ford; G/C. Ring; G/C. D. C. McKinley, Superintendent of Experimental Flying, R.A.E.; G/C. Stewart, Officer Commanding the Institute of Aviation Medicine; W/C. Macdonald; and W/C. J. Finch.

After dinner, the E.T.P.S. Commandant, G/C. S. Wroath, ordered the mess secretary, Mr. Setchell, to "bring the titfer"—the mortarboard traditionally worn by the "headmaster" on this occasion—and, in fine form, proceeded to deliver an excellent summary of the School's activities. He first welcomed the guests and in mentioning G/C. Stewart and "his merry band of unruffled men" made reference to a certain newspaper story dealing with the "brain barrier." He hoped that the I.A.M. would be successful in its programme of "organized confusion." He reported an improvement and extension of the School's flight-test instrumentation equipment, but regretted that this had brought with it an overload of work for the School's chief technical officer, Mr. J. Lang. He suggested that the industry might do well to attach trainee technicians as flight-test engineers at the School for a period of a year.

G/C. Wroath went on to say that during the past year the School had acquired a Canberra, a Hunter, and a Sea Hawk, and had received on loan an Avro 707 Delta. In addition the Admiralty had similarly loaned two Gannets, and the Army had provided Maj. I. Walton as an instructor on helicopters. The speaker expressed the hope that the fleet of aircraft would steadily be improved, not so much in numbers, as in different types of modern standard aircraft. The School's 40 pilots had achieved a not inconsiderable total of 5,500 hours' flying during the year, and an E.T.P.S. team had overwhelmingly won the National Gliding Contest team championship. Pupils had included two Americans, two Italians, one Frenchman, one Swede, one Dutchman, eight pilots from the Commonwealth Air Forces, and five from the Fleet Air Arm.

G/C. Wroath then called on Air Chief Marshal Sir John Baker to present the McKenna Trophy, for the most outstanding pupil of the course, to Lt. R. E. Moore, U.S. Navy. In his speech, Sir John summarized the work of his department of the Ministry of Supply, stating that its purpose was to see that the aircraft "served the Services." The M.o.S. was working smoothly and he felt that its work was a real contribution to the future of world aviation.

He spoke, also, of that approach to a new aircraft which regarded it as a vehicle and a receptacle for a weapons system, with all that the term implied. While guided weapons would undoubtedly be widely used, they would never take over entirely from the manned aircraft, because the latter brought to the point of action another element which the programmed machine could never replace—man's own judgment. Such judgment could certainly be fed into the missile before launching, but the missile would then outrun the judgment, and without it lose a great deal of its effectiveness.

Sir John Baker then presented the Trophy to Lt. Moore, who began his speech with "Commandant, Guests and Intruders" and ended with a reference to the friendly rivalry between the Fleet Air Arm and the U.S. Navy, with the toast "here's to the navy with the second biggest carriers . . . and the second best."

AGRICULTURAL DOUBLE

First Views of Two British Newcomers Designed to Commonwealth Requirements

THE first two British aircraft to be designed specifically to meet the requirements of New Zealand operators for a topdressing (aerial fertilizing) machine made their introductory appearances last week. They are the Auster B.8 Agricola, which made its first flight at Rearsby on December 8th, and the Edgar Percival P.9, which has been built by Edgar Percival Aircraft, Ltd., at Stapleford Tawney Aerodrome, near Abridge, Essex. Orders for both machines have already been placed by New Zealand operators.

The phenomenal growth of the use of aircraft for topdressing in New Zealand is evident from the following figures. Between 1950 and 1955 the number of aircraft used has increased from 15 to 230; the area treated annually from 48,750 to 2,783,800 acres; the number of operators from 7 to 49; and the annual hours flown from 2,140 to 70,790. The potential value of aerial topdressing was referred to by the Duke of Edinburgh in his British Commonwealth and Empire Lecture before the Royal Aeronautical Society last year, when he said it was expected that the technique was capable of increasing New Zealand's meat production by 50 per cent over the next ten years.

Of the 230 aircraft which were being used for this work in April of this year, the majority—163—were de Havilland Tiger Moths. There were 30 Cessna 180s, 19 Austers, 8 Fletchers FU-24s, 5 Pipers, 4 D.H. Beavers and 1 Lockheed Lodestar. Of these machines, only the Fletcher had been specifically designed for this type of work.

It has been found that the ubiquitous Tiger, although cheap to procure and adapt, simple to maintain and relatively safe for the pilot in the event of a crash, has a number of disadvantages. It is underpowered for this work, expensive to maintain, uncomfortable to fly for prolonged periods, and carries insufficient load. The performance of the Beaver leaves little to be desired, but for New Zealand operators it is in general too expensive in first cost and too large for the average-sized job. Something between the Tiger and the Beaver is indicated.

The two newcomers are similar in size and load capacity but, as is apparent from the photographs on the opposite page, they differ vastly in appearance. The two machines represent different approaches to the problem of meeting New Zealand's requirements, the Auster being a topdresser pure and simple, the Percival more of a general-purpose "aerial tractor" type of agricultural vehicle.

Both machines meet many of the requirements in the specification for "the ideal agricultural aircraft" circulated to manufacturers by New Zealand authorities in 1950, including rugged and simple construction, high degree of pilot-safety, ability to operate from small strips, hopper load of over 1,000 lb (normal category) and gross weight between 3,000 and 4,000 lb.

The purchase prices of the Agricola and of the P.9 have not been announced, but a New Zealand source has given £5,500 as the approximate cost of each. In the 1950 specification, it was required that new aircraft must be available "fly-away" from the N.Z. areodrome of delivery at a price not exceeding £NZ2 per lb gross weight. Further details of the two new machines are given below.

Auster B.8 Agricola

ONE of the two new British aircraft designed specifically to meet the requirements of New Zealand's topdressing operators, the Auster B.8 Agricola made its first flight on Thursday, December 8th at Rearsby. Its shape, as indicated in the photographs at the top of the opposite page, shows little resemblance to the familiar Auster family of high-winged light aircraft.

The Agricola is a single-engined, low-wing machine powered by a 240 h.p. Continental O-470-B engine. Its fuselage has a steel tube framework and is fabric-covered, and a rear enclosed cabin is designed to carry two passengers when the machine is not engaged on topdressing operations. This rear cabin is separated from the pilot's cockpit by the filler trunk of the hopper.

Maximum safety, the company states, is built into the cockpit in the form of a tough overturn structure. Further to reduce the danger of injury in the event of a crash landing, the hopper itself (capable of carrying 1,680 lb of fertilizing chemical) will be located below the pilot's cockpit. A strong shoulder harness and a foam rubber pad on the instrument panel are also provided.

For simplicity, essential instruments only are fitted in the cockpit, and a fully automatic engine-cooling system known as "jet cooling" enables the Continental engine to be operated at full power without fear of overheating.

The wide-track fixed undercarriage has 22-inch diameter low-pressure tyres, and port and starboard legs are interchangeable. Port and starboard ailerons and elevators, also, are respectively interchangeable. Flying-control cables run along the outside of the fuselage, for ease of inspection, and are nylon-covered to guard against corrosion. Another safeguard against corrosion caused by the superphosphates used in topdressing is the use of plastic paints and dopes specially developed for this aircraft.

To prevent dust accumulation in the rear of the fuselage, the section aft of the rear passenger accommodation is completely sealed off. In addition to being equipped for aerial topdressing, the Agricola has space provision for spray-tanks.

The prototype machine is expected to leave this country during next month for a demonstration tour of New Zealand.

AUSTER B.8 AGRICOLA
(Continental O-470-B engine of 240 h.p.)

Span	42ft 0in
Length	27ft 6in
Height	8ft 4in
Wing area	254.7 sq ft
Undercarriage track	14ft 4in
All-up weight (normal category, 1,120 lb load)	3,280 lb
All-up weight (agricultural overload, 1,680 lb load)	3,840 lb
Take-off run (1,680 lb load, no wind)	250 yd
Wing loading (overload case)	15.1 lb/sq ft

Edgar Percival P.9

FIRST product of the new Edgar Percival Aircraft company, the P.9 is the result of a study of the needs of Commonwealth operators made by Edgar Percival himself, designer of the famous pre-war Percival series of racing and touring aircraft. Detailed design work was started in May of last year and the company moved to its present base at Stapleford Tawney almost exactly one year later. From its hangar at Stapleford (which contains also one of the remaining Q.6s, Edgar Percival's last design), the P.9 was rolled out on Friday last.

A major objective in the design of the P.9 has been versatility, for the machine is envisaged as an agricultural all-rounder capable not only of economical topdressing work but also of spraying, supply-dropping and freight and passenger transport operations. To this end an extremely large cabin space aft of the pilot has been provided; access is by a large side door and rear clamshell doors.

The fuselage is a steel tube framework covered by fabric (aft) and non-stressed metal panels, and the high-mounted wing has a stressed light-alloy skin. Slotted flaps and drooping ailerons are employed. The machine is powered by a Lycoming GO-480-B engine of 270 h.p.

For maximum visibility, the pilot is placed as far forward as possible. For safety, he sits on a level which is above both the load and the engine. The main cabin, or cargo space, thus runs forward beneath the floor of the cockpit.

As mentioned, the machine can be used for general-purpose freighting. It can carry sheep or other small animals, bales of wool, 45-gallon drums of oil or petrol, fence-posts and fencing material, and other types of goods. For ambulance work two stretchers, one sitting patient and an attendant can be carried. If used as a passenger machine, the P.9 is a six-seater.

Top and cruising speeds of the P.9 (normal category) at sea level are estimated at 138 and 123 m.p.h. respectively, landing speed (light) being 37 m.p.h. Sea-level rate of climb is 1,090 ft/min. Grass-field take-off run with zero headwind is 145 yd (normal category) or 205 yd (agricultural overload).

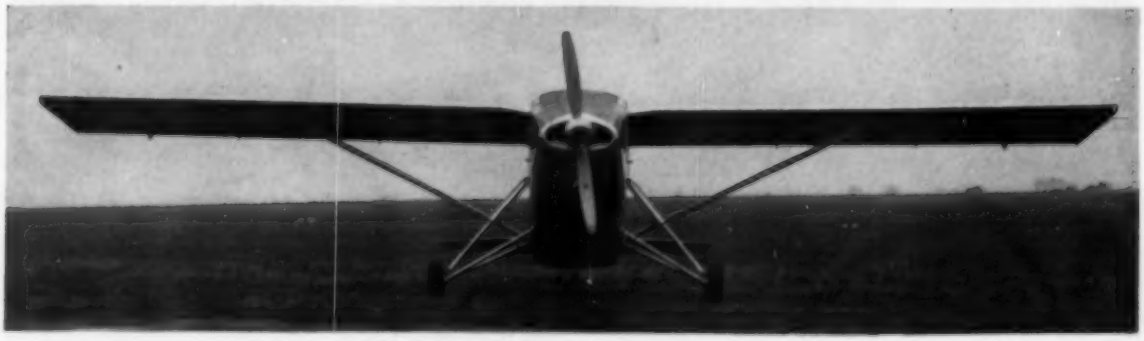
EDGAR PERCIVAL P.9
(Lycoming GO-480-B engine of 270 h.p.)

Span	43ft 6in
Length	30ft 0in
Height	8ft 9in
Wing area	227.6 sq ft
Undercarriage track	10ft 3in
All-up weight (normal category, 1,565 lb load)	3,415 lb
All-up weight (agricultural overload, 1,825 lb load)	3,675 lb
Take-off run (1,825 lb load, no wind)	205 yd
Wing loading (overload case)	16.1 lb/sq ft

FOR AGRICULTURAL FLYING : B.8 AND P.9

The Auster B.8 Agricola (above and right) is Rearsby's low-wing, Continental-powered contender for the topdressing market. Port and starboard legs of the wide-track undercarriage are interchangeable. The cockpit is designed to give the pilot maximum crash-protection.

The Edgar Percival P.9 agricultural all-rounder marks the return of this famous pre-war designer into the field of aircraft design and construction. In the four "Flight" photographs of this machine (below) the large volume of the freight/hopper space is apparent. Power is provided by a 270-h.p. Lycoming engine.



HERE AND THERE

ROTOR SCHOOL: Pupils and instructors at Hamble—(l. to r.) F/L. N. D. Glover, S/L.G.Webb (C.F.I.), M.Plt. W. Irving, R. Hazlehurst (instructor), Sgt. W. Booth. Flying the two Hillers are F/L. S. R. Kendal and F/L. W. H. W. Spencer. (See "A.S.T. Helicopter Contract.")

B.E.25—a Going Concern

THE first run of the Bristol B.E.25 two-spool turboprop, intended for late-model Britannias and the projected Bristol/Convair/Canadair 500 m.p.h. airliner, was successfully completed last week-end. Nor was it a bare engine on test, but a complete powerplant.

Raising the Mach

THE Chance Vought Crusader is reported to have flown last month at a speed of 1,050 m.p.h., at an unspecified altitude. For security reasons, no official confirmation of this performance has been given by the U.S. Navy authorities.

Rocket Propulsion Appointment

IT was recently announced by the Ministry of Supply that Mr. J. E. P. Dunning has been appointed chief superintendent, Rocket Propulsion Department, Royal Aircraft Establishment, with effect from December 1st, to succeed Dr. T. P. Hughes.

Canadair Expansion

ON December 1st the Canadair, Ltd., division of the General Dynamics Corporation opened their recently extended test and development installations, which now include a completely new engineering building and a guided-missile facility. The establishment is situated close to the main plant in Montreal. At present the major commitment of the guided missile engineering section is the development of the Velvet Glove, an air-to-air test vehicle originally designed by the Canadian Armament Research and Development Establishment at Valcartier. Large numbers of test programmes on the missile are currently in progress in the new laboratories. Structural test demonstrations put on for the benefit of the many distinguished visitors on opening day included the integrity of a Sabre tailplane, the aeroelastic behaviour of a missile fin and the resonance of a missile wing (sonic exciter) and a complete missile (electro-magnetic vibrator). There was also evidence of the considerable test programme now under way on the Canadair CL-28 (Britannia M.R.) and a mock-up was exhibited of the cockpit of a proposed side-by-side twin-jet trainer.

Javelin Lost

WHILE on a test flight from the A. and A.E.E., Boscombe Down, last week, a Gloster Javelin piloted by S/L. A. D. Dick was destroyed in an accident at Rowborough Corner, between Ryde and Sandown, Isle of Wight. The pilot baled out and landed unhurt in marshy ground a short distance away, and was picked up by a Naval helicopter from Lee-on-Solent. He is reported to have been flying at about 45,000ft in company with other aircraft when the Javelin went out of control.

A.S.T. Helicopter Contract

A "CONSIDERABLE number" of helicopter pilots are to be trained for the R.A.F. at the new helicopter school of Air Service Training. The Service is sending trainees to the school on three-week courses, which are followed by advanced training by the manufacturers of the types of helicopter to be flown operationally. The initial course of four R.A.F. pilots has already passed out at A.S.T., and another course is in progress. Flying training—Hiller 360s are the aircraft employed—averages 20 hr, including about 8 hr dual and 12 solo. Next year, incidentally, A.S.T. will be celebrating their first 25 years in business.

German Air Force Training

SEVEN pilots of the West German Air Force, the first to begin military flying again since the war, have reported to the U.S.A.F. base at Landsberg for training as instructors. All are former German Luftwaffe pilots.

Courageous Rescue

AN exceptionally skilful casualty pick-up was achieved last Monday by a Naval Whirlwind pilot, Lt. A. Hudson, R.N.V.R. He landed on the 36ft × 36ft roof of St. Helen's fort, in Spithead, in order to take off the light-keeper, who was seriously ill. Lt. Hudson achieved the operation successfully, in spite of the fact that a gale was blowing and that his rotor blades had only 4ft clearance from a roof-top mast; and from the roof to the sea was a 50ft drop. He then flew the sick man to hospital at Newport, I.o.W., landing in the grounds.

A Folland Post

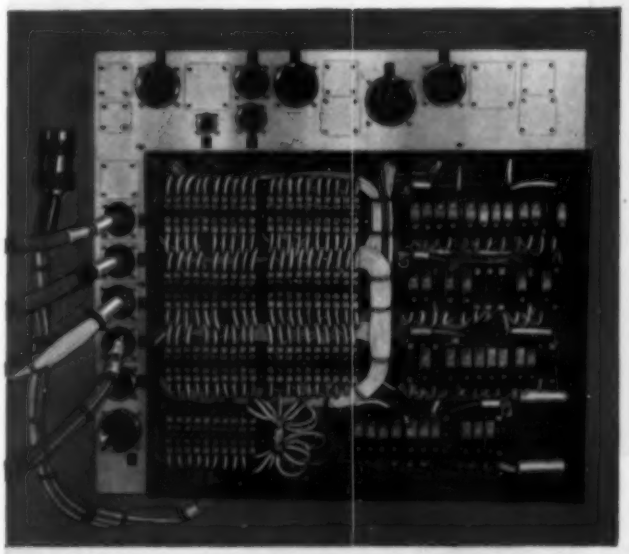
WELL known in the aircraft industry for many years, Mr. Derek Brade has joined Folland Aircraft, Ltd., as chief flight development engineer. He was apprenticed to Armstrong Whitworth in 1930 and was later employed in the company's design department. From 1941 to 1946 he was a member of the staff of the Director of Technical Development, M.o.S. Mr. Brade then joined General Aircraft, Ltd., as chief flight development engineer, remaining in the same post when the company merged with Blackburns.

Survey Prince—Strike Aircraft

AN air-directed "strike" of valuable deposits of ore in Norway is the outcome of a contract awarded last year to Hunting Geophysics, Ltd., by Titania A/s, for the aeromagnetic survey of some 300 square miles in Norway's south-west. The object was to discover the location and extent of a titanium ore, ilmenite. For three weeks last year the magnetometer was flown up and down the area in a Hunting Percival Prince at 500ft and 300ft above the rocky, jagged terrain. The aeromagnetic records and other data were sent back to England for interpretation, and a drilling programme drawn up. It is now learned that, in the first area thus surveyed, the Titania company's diamond drills have encountered over 100 million tons of good-quality ilmenite.

WILLING STRIKERS: The newest carrier-borne strike squadrons of the Fleet Air Arm are Nos. 830 and 831, now operating from H.M.S. "Peregrine" (R.N.A.S. Ford), where the disbanded 813 and 827 Wyvern Squadrons were commanded by Lt-Cdr. Crossley and Lt-Cdr. Richardson. This picture shows the Commanding Officers of the new squadrons, Lt-Cdr. Stanley Farquhar and Vivian Howard, with officers, C.P.O.s and P.O.s. In the background are some of the squadrons' Westland Wyvern S.4s (Armstrong Siddeley Python).

THE JAVELIN RELIES ON Plessey



JUNCTION BOXES

The box illustrated—one of the seventeen Plessey junction boxes employed on every Javelin—has 242 separate wires, 439 crimped joints, 19 outlets and uses 740 feet of cable.

THE PLESSEY COMPANY LIMITED • ILFORD • ESSEX

A65

The dimensional accuracy and super finish of Lucas components for the Duplex III burner, ensure fuel atomisation over a wide flow range and will service engines up to high altitudes.

FUEL AND COMBUSTION SYSTEMS FOR GAS TURBINE ENGINES

LUCAS

JOSEPH LUCAS (GAS TURBINE EQUIPMENT) LTD., BIRMINGHAM & BURNLEY

Lucas-Rotax (Australia) Pty. Ltd., Melbourne and Sydney, Australia.
Lucas-Rotax Ltd., Toronto and Montreal, Canada.

BACKGROUND to STRASBOURG

Europe Takes a New Look at Some Old Air-transport Problems

The Council of Europe headquarters at Strasbourg, in which the first European Civil Aviation Conference opened on November 29th.

AN international conference is in progress. The scene is a large, well-lit hall, thinly occupied by perhaps 60 or 70 people, the majority in semi-circular, stepped-up rows of desks forming an amphitheatre. The wall behind the chairman's rostrum, which faces the rows of desks, contains glazed panels through which translators and sound-controllers can view the proceedings.

In the desks nearest the rostrum are seated delegates from 19 European nations. Each delegation is provided with an identifying plaque and a microphone. The rows behind contain observers from a like number of international organizations. Furnishings are sober—beige carpeting, dark wood furniture and red-leather-covered chairs.

For those who speak it fluently, English is the language of the conference. Every speech, however, is translated into four of five languages (English, French, German, Italian and Dutch), and every delegate or observer has earphones, volume control and a channel-selector enabling him to hear the translation of his choice or an amplified version of the original. Acoustics, heating and air-conditioning are excellent.

Such is the scene, except in minor detail, at any of twenty or more forgotten international conferences. The description applies, in fact, to the first session of the European Civil Aviation Conference, which opened on November 29th and is still in progress at the time of writing. It is being held in the Alsatian city of Strasbourg, on the premises of the Council of Europe.

In a quiet and unspectacular way, conferences of this kind can have profound effects on political, commercial and personal activities in the countries represented, and yet they pass almost unnoticed. The reasons for this fact are not hard to find. In the first place, the pace of discussion is slow—inevitably, perhaps, bearing in mind differences of language and viewpoint—so that except for those directly involved the intellectual atmosphere is liable to stagnate. If official observers become suffocated with boredom, it is hardly surprising that journalists tend to avoid international conferences altogether.

Again, remarkably few delegates approach the conference in a truly international spirit; policies are usually founded on the interests of one government or one national airline. Who, then, can blame the public for adopting a sceptical attitude?

This particular conference *could* bring about a revolution in international air transport. Alternatively, it could prove a complete waste of time or—more probably—yield limited though not useless results. Whatever its outcome, the Strasbourg conference is worth a moment's study to anyone involved in civil aviation, because it marks a positive stage in the evolution of the rules to which the game of international air transport is played. It also provides an opportunity to review those rules—the basis on which traffic rights are exchanged between nations—as they have developed to date.

An unsuccessful attempt to evolve an international formula for exchanging traffic rights was made eleven years ago at Chicago, at a conference attended by representatives of nearly 70 nations. The basic problem was, of course, one of substituting a multilateral agreement for the complicated system of bilateral agreements. Two proposals were made which would have provided a very simple answer to this problem. One, from Australasia, called for a pooling of national interests in the operation of all major international routes. America, on the other hand, advocated a "free-for-all." While accepting the principle of freedom of the air as ultimately desirable, Britain successfully opposed the idea of unrestricted competition, in the belief that civil aviation would for many years be incapable of "flying on its own," and that the desire for prestige would produce a wasteful degree of competition at public expense. In establishing her own system of "regulated competition," administered by the Civil Aeronautics Board, the United States had admitted the truth of this argument—but she failed to appreciate the need for an international equivalent of the C.A.B., despite the fact that inter-airline competition outside America could be just as intensive, and often more costly, than in America.

According to the internationally accepted United Kingdom definition, "freedom of the air" can be exercised in six ways, which have come to be known as the Six Freedoms.

The First Freedom is the right of "innocent passage": *e.g.*, a B.E.A. aircraft passing through French airspace on its way from London to Zurich.

The Second Freedom—as exercised by a Gibraltar-bound Hunting-Clan aircraft stopping at Biarritz to refuel but not to pick up or set down passengers—is the right to land abroad for non-traffic purposes.

The Third Freedom provides for the setting-down in a foreign country of traffic from the country of origin of the aircraft; example: a B.O.A.C. aircraft carrying British passengers to New York.

The Fourth Freedom covers the embarkation of foreign traffic destined for the country of origin of the aircraft; example: a B.O.A.C. aircraft carrying American passengers from New York.

The Fifth Freedom is the right to carry traffic between foreign countries; example: a Sabena service carrying passengers between Manchester and New York.

The Sixth Freedom, usually referred to as cabotage, is the term applied to traffic within the borders of a foreign country. The K.L.M. service between Hamburg and Bremen is an example of cabotage.

The main result of the Chicago conference, so far as traffic rights were concerned, was a virtually automatic exchange of First and Second Freedoms between all the countries who signed the Chicago Convention. Exchange of the remaining Freedoms remained a matter for bilateral negotiation.

Some of the subsequent bilateral agreements granted unrestricted freedom of operation to the airlines of the countries concerned. Most, however, follow the lines of the famous compromise between Britain and America reached at Bermuda early in 1946. The Bermuda agreement's major achievement was that it provided for reasonable increases in the capacity offered by airlines of either side, and for the exercise of Third, Fourth and Fifth Freedom rights, without sacrificing the principle of regulated competition.

At Geneva, in 1947, an international conference was staged by the International Civil Aviation Organization (which body was formed as a result of the Chicago conference) with the object of drafting a new multilateral agreement. Britain and America hoped that the Bermuda bilateral might be translated into a multilateral code for the exchange of rights. The conference foundered, however, on the rock of the Fifth Freedom. It should be noted, perhaps, that Fifth Freedom rights are essential to the economic operation of a majority of long-haul services. Since Geneva such rights have continued to be negotiated on a bilateral basis, with complications best left to the imagination.

In the spring of 1954, at the suggestion of the Council of Europe, I.C.A.O. convened an international meeting at Strasbourg on the co-ordination of European air transport. The agenda listed a variety of problems—political, commercial and technical. Essentially, the importance of the Strasbourg conference lay in the fact that it represented the first attempt to settle the global traffic-rights problem on a regional basis. The outcome of this preliminary conference may be summarized as follows:—

Three major recommendations were made. The first, dealing with exchange of traffic rights for scheduled services, declared that "governments should give support to co-operative studies among airlines aimed at the development of traffic by such measures as interchange of routes, route arrangements between two or more airlines, relaxation of restrictions based on distinctions between

M. P. J. M. Nottet (right), leader of the Belgian delegation, takes office as chairman of the Strasbourg conference. With him is M. Henri Bouche, first vice-president of the I.C.A.O. Council.

BACKGROUND TO STRASBOURG . . .

traffic freedoms, improvement of services and of airline productivity, reduction of operating costs, speedy performance of ground services, establishment of operating or servicing pools."

The second recommendation urged that as interchange involved legal problems relating to the chartering or hiring of aircraft, the Council of I.C.A.O. should consider the need for an international air law convention on this subject.

The conference also pointed out that operation of air-ground communications by radio telephony would improve the economics of European transport and urged "better implementation of the I.C.A.O. navigational regional plan."

The 1954 Strasbourg meeting also made a number of secondary recommendations designed mainly to reduce the time-wasting and costly effects of frontier procedures such as visas, customs examinations, manifests and health regulations. European states were asked to ensure that "any treatment accorded to air transport at airports was no less favourable than that given to surface transport at docks, bus or rail frontier posts." The conference also advocated a more liberal approach to the granting of rights to services which did not affect the interests of scheduled air transport: e.g., emergency, humanitarian, taxi, charter and freight flights.

Boiled down into practical terms, many of these recommendations meant very little, since the existing machinery for international discussion of civil aviation problems was fully capable of reaching similar conclusions and, probably, of taking equally effective action. The most important outcome of the first Strasbourg meeting was its decision to set up a European civil aviation conference. It is this conference which, as reported above, held its first session at Strasbourg on November 29th and is still under way at the time of writing.

The conference has set itself a less ambitious agenda than its predecessor and for this reason alone appears more likely to produce some lasting results. States taking part in the conference are: Australia, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Also present, but without voting rights, are observers of other member states of I.C.A.O. and of the following international organizations: Council of Europe, United Nations, U.N. Economic Commission for Europe, Organization for European Economic Cooperation, Universal Postal Union, World Meteorological Organization, International Telecommunications Union, European Conference of Ministers of Transport, Fédération Internationale des Transports Aérien Privés, International Air Transport Association, International Chamber of Commerce, International Federation of Airline Pilots Association, International Institute for Unification of Private Law, International Law Association, International Union of Aviation Insurers, International Aircraft Brokers' Association, Air Research Bureau, Institut Francais du Transport Aérien, International Association of Aircraft Manufacturers.

The first action of the conference was to elect a chairman—M. P. J. M. Nottet, leader of the Belgian delegation—and other officials. Next, it was decided to set up two commissions, constitutional and economic, dealing with separate items on the agenda. The constitutional commission was appointed to deal with items 1 and 2, the economic body was divided into sub-commissions, one dealing with commercial rights and the other with remaining points, including helicopters and interchange services.

The provisional agenda was as follows:

(1) Relationship with the International Civil Aviation Organization and arrangements for future meetings of the European Civil Aviation Conference.
(2) Relationship between the Brussels Air Research Bureau and the European Civil Aviation Conference.
(3) Exchange of views on the question of helicopter ferries in Europe.
(4) Exchange of views on a multilateral agreement for scheduled services.
(5) Exchange of views on a multilateral agreement for non-scheduled services.
(6) Consideration of matters relating to the interchange of aircraft.

Soon after the conference opened it appeared probable that only two or three agenda items were likely to yield positive action; once again, perhaps, the conference had too much on its plate.

Whatever the theoretical advantages of interchange services, for example, there is little doubt that if European airlines wished to interchange they could do so through the medium of normal inter-carrier and government negotiations and without the aid of an international conference. Again, it is difficult to appreciate the purpose of an international discussion, at government level, of helicopter services, whose problems are largely technical and financial rather than political. Justifiable Belgian pride in the achievements of Sabena's helicopter network may have led to the inclusion of this subject on the agenda.

The constitutional aspect is interesting, because the future status of the conference was uncertain during the opening days at Strasbourg. A move was afoot, one gathered, to establish the European Civil Aviation Conference as a permanent body. The significance of such a step would depend, of course, on the conference's powers, and its terms of reference, its relations with I.C.A.O. and its effects on fares and rates policies, which have since 1946 been determined through the traffic conferences of the International Air Transport Association. Establishment of a separate European air transport organization might generate similar action in other regions. In international aviation circles, this possibility gives rise to some concern: such conferences might, in undeveloped regions, restrict rather than expedite the growth of air transport. As we have suggested, it is by no means certain whether the European conference will show a real dividend.

The question of the conference's relations with the Air Research Bureau is also of interest. As its name implies, the Bureau is essentially a research organization, though—depending on the way in which the conference develops—it might take on a more political character. The A.R.B. (not to be confused with the Air Registration Board) is sponsored by eight of the European national airlines, including B.E.A., and has a small secretariat with headquarters in Brussels. Its main duty is to perform on behalf of the members, market surveys of a scope beyond their individual resources. In the past two years it has produced three extremely useful documents in the form of traffic studies, two dealing with the development of passenger traffic and the third with cargo. Any move to adopt the Bureau as the conference's sole representative of the European air transport industry would not, however, go unopposed: the International Federation of Independent Air Transport (F.I.T.A.P.), for example, represents a powerful body of airline operators, many of whom operate scheduled services but are ineligible for membership of the A.R.B.

At the request of the 1954 Strasbourg conference, I.C.A.O. produced a draft agreement for a multilateral convention on scheduled services in the European region, and this has been presented for discussion by the present conference. If adopted, this would represent the first victory over a previously insoluble problem. Opinion at Strasbourg was, however, that the draft would not be adopted except, perhaps, in such qualified form that it would not mark any significant improvement on the present system of bilateral negotiations.

In the limited field of non-scheduled services, the prospects of agreement were somewhat brighter. In essence, the draft of the multilateral document proposed by I.C.A.O. provides that signatory states should give free passage to the following classes of non-scheduled traffic: flights for the purpose of meeting emergency or humanitarian needs; taxi-class operations employing aircraft with seating capacity for up to ten passengers; flights on which the entire space of an aircraft is used by a single person (individual, firm, corporation or institution) for his own purpose and no part of the space is resold; single flights or flights of not greater frequency than once a month.

Even in this restricted sphere of operations, however, the prospects of agreement are reduced by the lack of an internationally accepted definition of what constitutes a non-scheduled service.

HUNTER F1, F4 AND F6

HUNTER TRAINER

SWIFT

SUPERMARINE N113

DE HAVILLAND 110

COMMONWEALTH SABRE

LANSEN

DRAKEN

MYSTERE IVB AND IVN

SUPER MYSTERE

CANBERRA

VALIANT

VAUTOUR

COMET 2, 3 AND 4

CARAVELLE

FAIREY DELTA 2

All

powered by

ROLLS-ROYCE

AVON

ENGINES

ROLLS-ROYCE LIMITED · DERBY · ENGLAND

G

25,389,246 miles

were flown by BEA aircraft during the year ending October 31st, in serving 67 airports in Great Britain, Europe and North Africa. In the course of these operations BEA carried 2,128,617 passengers—330,013 more than in the previous year.

fly BEA in Europe's finest airfleet

BRITISH EUROPEAN AIRWAYS

THE FELIXSTOWE FLYING-BOATS

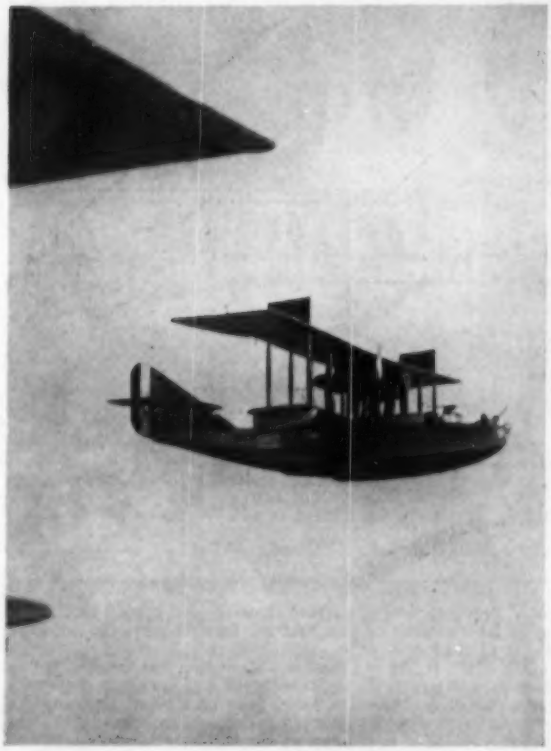
HISTORIC MILITARY AIRCRAFT, No. 11 (PART 2)

J. M. BRUCE, M.A.

THIS is the second instalment of Mr. Bruce's article on a famous family of World War I flying-boats. Part I appeared on December 2nd.

THE production version of the F.2 was designated F.2A. It had more powerful marks of the Rolls-Royce Eagle engine, and incorporated a number of refinements. From the operational point of view, one of its greatest assets was its good defensive armament. The design of the hull was such that two Lewis guns could be fitted, one on each side of the hull behind the wings. Each gun was mounted on a bracket which could be swung outboard through a side hatch; from that position the guns' fire could converge at a point only twenty feet behind the rudder. Further guns were mounted on the bow and upper rear cockpits. A bomb load of 460 lb could be carried, with fuel for eight hours at cruising speed; without bombs, flight endurance could be extended to ten hours.

Production F.2As began to appear late in 1917. Their appearance had been delayed by an official decision to replace the original 23in-diameter gun ring by one of 20in: this necessitated structural changes which held up production. The type was



popularly known, like the Curtiss H.12 before it and the F.3 after it, as the Large America. This indiscriminate use of the name makes it difficult to distinguish one type from another in the narratives of the actions in which the big boats participated so gallantly.

Despite its shortcomings, the Curtiss H.12 had clearly established the case for big flying-boats. The famous "Spider Web" patrol flown by the boats of Felixstowe air station was begun by H.12s. On April 13th, 1917, the Curtiss H.12 No. 8661 made the first patrol over the octagonal figure which, centred on the North Hinder Light Vessel, effectively and drastically hampered the depredations of enemy submarines in the four thousand square miles of sea covered by the patrol. By the end of the month the H.12s had made 27 patrols, in the course of which they sighted eight enemy submarines and bombed three, and had an engagement with German destroyers. The patrol's first victim was the submarine U.C.36, which was sunk on May 20th, 1917, by an H.12 (Flt. Sub-Lts. C. R. Morrish and H. G. Boswell).

Zeppelins, too, fell to the attacks of the Curtiss Large Americas. One of the many exploits of No. 8666 of Great Yarmouth air station was the destruction of L.22 on May 14th, 1917; and No. 8677 of Felixstowe shot down L.43 exactly one month later.

It seemed reasonable to assume that even more successes might be scored by the F.2As, since they could be flown in sea conditions beyond the capabilities of the H.12s.

In July 1917 the Government decided to double the size of the flying Services. Some two months previously, the estimated number of flying-boats of the Large America type required to carry out the 1918 programme had been set at 180, but that number was increased to 426. The average life of one of the big boats was estimated to be six months. This meant that 852 aircraft would be required to maintain the establishment of 426 throughout a period of twelve months. Not even the simplicity of the Porte system of construction could permit production on that scale in the time available. The situation was relieved when the U.S. Navy Department agreed to equip five seaplane stations; it was also decided that the 60 flying-boats needed for the Mediterranean area should be built at Malta. The establishments of English stations were reduced, whereupon the required number of Large Americas was correspondingly reduced from 426 to 234. (In March 1918, orders for the F.2A had totalled 161; and for the later F.3, 263. Of these, only ten F.2As and one F.3 were in service at that time.)

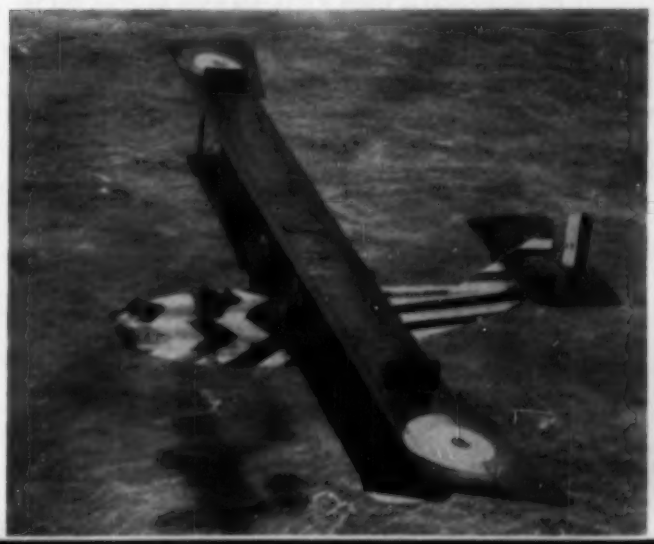
But even the reduced figure of 234 was never realized. Demands for Rolls-Royce engines so far exceeded the supply that it was estimated that only 170 Large Americas could be completed by the end of May 1918. In point of fact, only 104 had been delivered by that date. These difficulties may have been responsible for the rebuilding of several H.12s with Porte-type hulls and F-boat tail units. When modified in this way they were indistinguishable from F.2As and could be identified only by their serial numbers. They were frequently—and officially—described as F.2As.

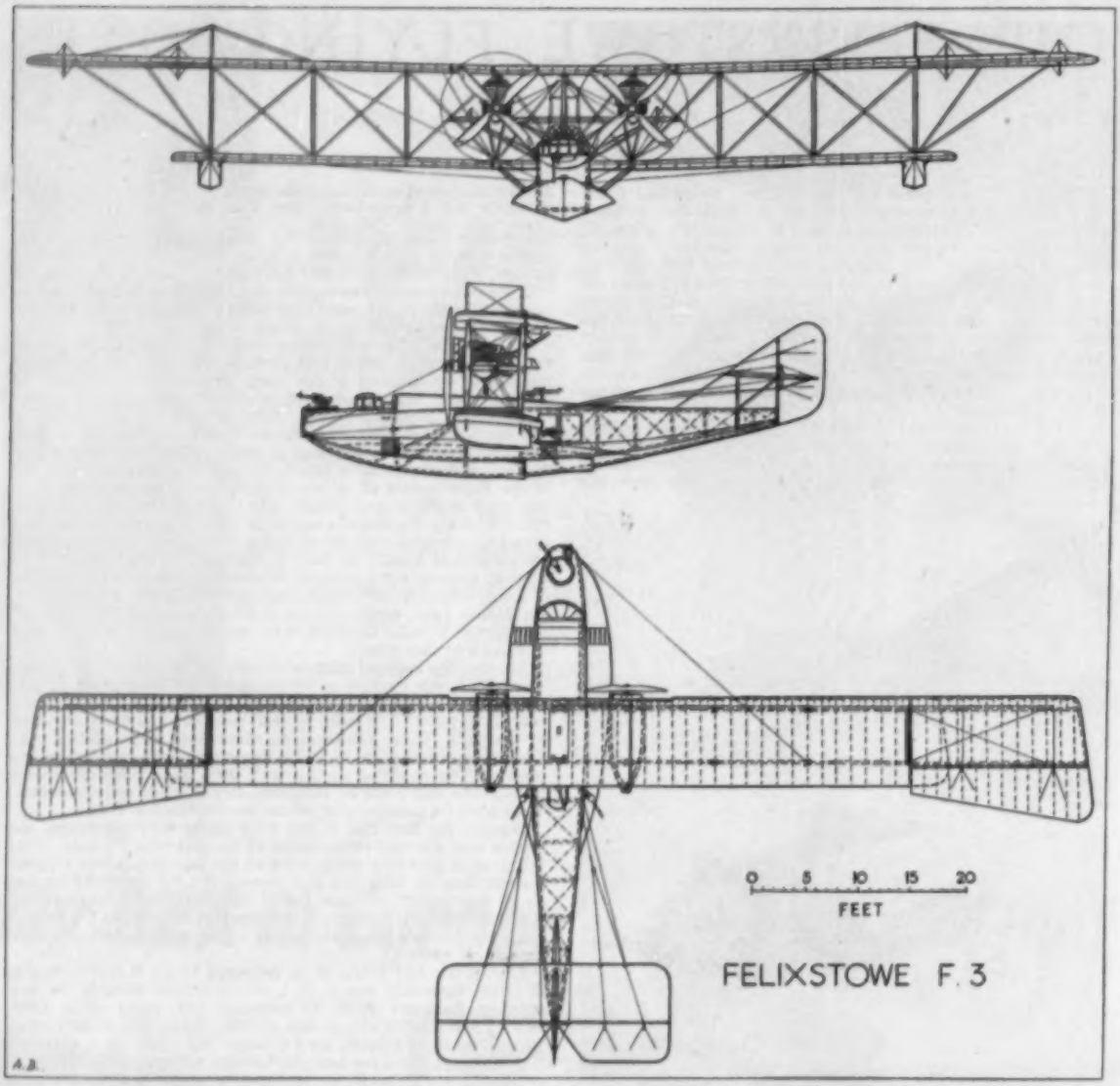
Despite the fact that F.2As were never very numerous, the type is now the best-remembered of the war-time F-boats. That this is so is probably attributable to the fact that it was a better aircraft than the later F.3, and because the F.5 appeared too late to go into operational use before the Armistice. Furthermore, more than one writer appeared to regard all F-boats as F.2As, and some narratives have consequently to be treated with a certain amount of reserve.

One of the first F.2As to be delivered to the R.N.A.S. station at Great Yarmouth was N.4511, which arrived there in the first week of February 1918. In common with many of its kind, N.4511 had trouble with its fuel system. A partially choked petrol pipe delayed its take-off on February 5th, 1918, for a patrol to Terschelling; when the boat did become airborne, fabric stripped off one of the blades of the starboard airscrew, and the vibration sent the F.2A down to a hurried landing.

The same boat took off on the same patrol on February 16th, but one hour out from base a clogged filter in the gravity tank

"Despite the fact that F.2As were never very numerous, the type is now the best-remembered of the wartime F-boats." In the lower view is an F.2A with open cockpits, sometimes known as the F.2B.





THE FELIXSTOWE FLYING-BOATS . . .

brought it down on the water. The crew consisted of Flt. Cdr. F. W. Walker, Flt. Lt. E. A. Bolton, Leading Mechanic Walker and Air Mechanic Henderson; they all owed their lives to home-made wireless apparatus which anticipated by a quarter of a century the dinghy radio of World War II. On board the flying boat was a five-foot linen box-kite and aerial with which Ldg. Mech. Walker had been experimenting at Great Yarmouth; and with its aid the crew were able to establish and maintain wireless communication with their base. Fixes were obtained by shore stations, and the crew were picked up by H.M.S. *Glow-worm* eight miles downwind from the position she had been given.

The principal defect in the fuel system of the F-boats lay in the great length of piping it contained. The main tanks were in the hull, and wind-driven pumps forced the fuel up to a gravity tank in the upper centre-section; the carburetters were fed from the gravity tank.

The enemy had no aircraft comparable with the F-boats. His overseas patrols were performed by float seaplanes, principally Friedrichshafen FF.33 variants, with some Gotha W.D.14s and Brandenburg GWs for long range work and torpedo-dropping. For fighting, the Brandenburg W.12 two-seat floatplane proved to be a useful weapon: the W.12 and its successor, the W.29 monoplane, were thorns in the flesh of the crews of the F-boats, for the Brandenburgs were small, fast and manœuvrable, whereas the flying-boats were large, slow and cumbersome. Nevertheless, the boats' heavy armament enabled them to give a good account of themselves, as shall be told, and the Brandenburgs did not have things all their own way.

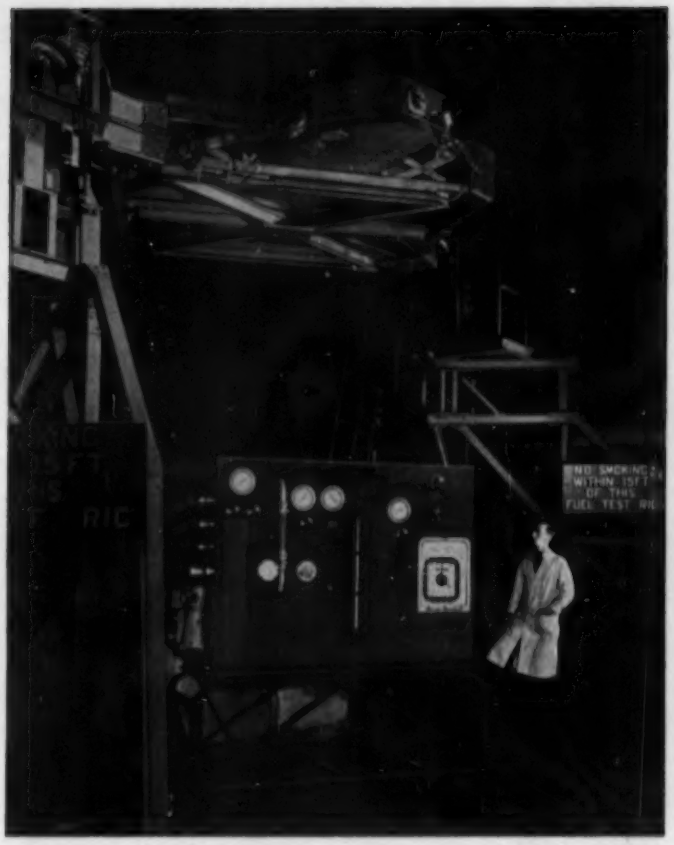
One of the F.2As of Felixstowe air station was fitted with two gunners' cockpits on the upper wing; each of the elevated gunners had a pair of double-yoked Lewis guns on a Scarff ring, and the bow cockpit was similarly equipped. This experiment was probably intended to produce an escort fighter to accompany and protect the patrolling flying-boats; but it seems to have been unsuccessful.

On May 10th, 1918, the Zeppelin L.62 was attacked by an F.2A from Killingholme air station at 8,000 ft above the Heligoland minefields; the boat was flown by Captains T. C. Pattinson and A. H. Munday. The latter officer manned the bow gun, and both he and the F.2A's engineer, Sgt. H. R. Stubbington, appeared to score many hits. The Zeppelin flew away eastwards, losing height, and was later seen to explode and fall in flames. A broken oil feed pipe forced the F.2A down on the sea, but the break was repaired by Sgt. Stubbington and the flying-boat took off in time to escape the vengeful attentions of seven German destroyers.

The F.2A remained in service until the Armistice, after which it was superseded by the F.5. It is doubtful whether a distinct F.2B variant was built, but that designation has come to be applied to an open-cockpit version of the F.2A.

The F.2C did not proceed beyond the prototype stage. It had a lighter hull with steps of revised design and a forebody with contours rather different from those of the F.2A. The pilot's cockpit had no cabin top, and the bow cockpit was farther back

The fuel goes 'round and around



Between the arms of this ENGLISH ELECTRIC test rig at Warton there is room to put the fuel system of a modern jet aircraft—full size, and complete with all tanks, pipes, pumps, vents and cocks.

From the tanks can be pumped fuel at any desired rate up to that representing the full throttle take-off condition. Into it can be pumped simultaneously enough fuel to keep the level at any required point—thus maintaining steady conditions of test.

And while all this pumping and counter-pumping is going on, the entire outfit can be rotated bodily through any required angle, at any required rate of rotation (within limits), thus simulating as nearly as may be the effect on the fuel system of high-speed manoeuvres in flight.

If the test rig proves that the calculations of the ENGLISH ELECTRIC test team were correct—well and good. If not—how much better that defects should be shown up on the ground than in the air! In this open-minded atmosphere the long, costly and elaborate testing on the ground does a lot to shorten the much longer, and certainly more dangerous, process of trial and error in the air.

'ENGLISH ELECTRIC' aircraft

THE ENGLISH ELECTRIC COMPANY LIMITED
QUEENS HOUSE · KINGSWAY · LONDON · WC2

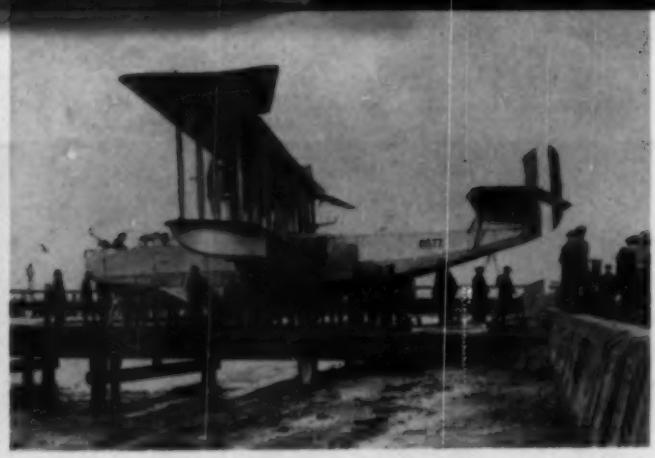
Design starts from an attitude of mind

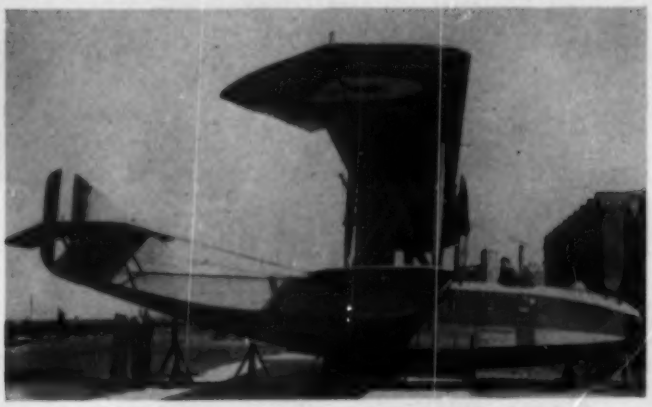
For the new
SAPPHIRE
and for every Armstrong Siddeley ever made

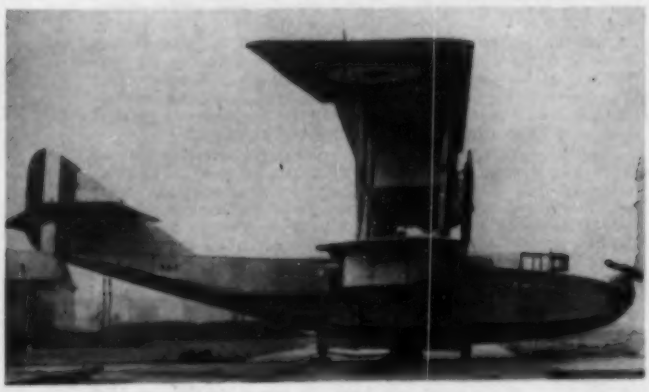
ARMSTRONG SIDDELEY
RECOMMEND
CASTROL

THE MASTERPIECE IN OILS

Castrol







From top to bottom: Rebuilt Curtiss H.12 with Porte-type hull (this aircraft, No. 8677, shot down Zeppelin L.43); the F.2C, which saw operational service but did not go into production; the F.3 prototype, which appeared earlier than the F.2A; and the production version of the F.3, with leading edge slightly recessed at the centre-section.

THE FELIXSTOWE FLYING-BOATS . . .

on the hull; there were no waist gun-positions. The F.2C was powered by two 275 h.p. Rolls-Royce Mk II (322 h.p. Eagle VI) engines, and underwent official trials on June 23rd, 1917. Its performance was a little better than that of the F.2A, but not sufficiently so to justify interference with the F.2A production programme.

Nevertheless, the F.2C saw operational service. On July 24th, 1917, flown by W/C. Porte himself, it was one of five flying-boats sent out on patrol from Felixstowe. Near the North Hinder Light Vessel the patrol attacked a U-boat: two of the five 230-lb bombs which sank the U.C.1 on that occasion came from the racks of N.65, the F.2C.

At one time the F.2C was fitted with experimental bomb-release gear operated by compressed air. This gear was relatively complicated, and Sqn. Cdr. Hallam found it was not dependable when, one day late in September 1917, flying N.65, he attacked a surfaced U-boat; his bombs failed to leave the racks.

Earlier than the F.2C in point of time was the F.3, of which the prototype (N.64) underwent official tests on February 9th, 1917. This flying-boat was designed throughout by Porte and was slightly larger than the F.2A: its hull was three feet longer, and its wings were of greater span and chord. In appearance the F.3 was very similar to the F.2A, and could be distinguished only by the slight recessing of the leading edge of the upper wing immediately behind the airscrews. The upper wings of the F.3 had the same large overhang and ailerons of the same inversely-tapered shape as those of the F.2A; and the king-post structures above the outermost interplane struts were similarly clothed in fabric. The fin surfaces thus formed were characteristic of the F-boats, but they had no designed aerodynamic function.

The hull of the F.3 was built on the Porte principle, and was planked in the same way as that of the F.2A. At first, the tops of the fins were planked with birch three-ply, but on later F.3s the normal double-diagonal planking was used. An unsatisfactory feature was the design of the floors, which were rebated into the keelson on either side. This division of these important transverse members weakened the structure, and caused the planking to spring readily along the garboard: consequently the hulls leaked badly. As a palliative, intermediate timbers were later introduced.

The prototype was first flown with two 320 h.p. Sunbeam Cossack engines, and was distinguished by vertical surfaces fitted between the interplane struts immediately outboard of the engines. Production F.3s were powered by a pair of Rolls-Royce Eagles, and did not have the interplane surfaces fitted.

Whereas the F.2A could carry only two 230-lb bombs, the F.3 could carry four. It may have been this fact which commended the F.3 in official eyes, for it was put into production on a larger scale than the F.2A. There are indications that this was done against the advice of John Porte and his staff: indeed, Maj. Rennie later stated that the F.3 should never have been put into production. In service, the type was never so popular as the F.2A, for it did not handle so well as the earlier type.

The decision to build flying-boats at Malta has already been mentioned. Some F.3s were built in the dockyard there by local workers: the men were skilled boat-builders, and much of the fabric work was done by Maltese women under the supervision of Lady Methuen, the wife of the Governor.

The F-boats were used with another product of John Porte's lively imagination; one which might have had a greater influence on the course of the war had its development been pursued with more energy. As early as September 1916, Porte had suggested that the radius of action of flying-boats would be greatly increased if they could be carried across the North Sea on lighters in order to be able to take off near their objectives. He submitted a rough drawing of the type of craft he had in mind: it was a channel-shaped vessel which could be partly submerged by flooding tanks within its hull. A flying-boat was then to be floated in, the water ejected from the lighter's tanks by means of compressed air, and the aircraft thus raised clear of the water. Porte stated that the lighter should be strong enough to be towed at 25 knots by a destroyer.

After a visit by Admiralty representatives to Felixstowe, design work began at once. It was decided that only the stern portion of the lighter should be submersible, and that the flying-boat should be hauled aboard by means of a winch on the lighter. An order for four lighters was placed in January 1917, but it was not until June that the first was successfully tested at the builder's works. Towing trials were conducted in the

One of the towed lighters designed by John Porte for the transport of flying-boats in order to extend their operational range.

THE FELIXSTOWE FLYING-BOATS . . .

Solent during July and were so successful that it was proposed to order fifty immediately; but the Admiralty required further trials to be made in the North Sea.

These trials were conducted under Commodore R. Y. Tyrwhitt on September 3rd, 1917; and a lighter with a flying-boat (presumably a Curtiss H.12) on board was towed at speeds up to 32 knots. An order for 25 additional lighters was placed immediately; the number was later increased to 50. The lighters were built by Royal Engineers at a new Government shipyard at Richborough. The first was not delivered until May 1918, and only 31 had been received by the time of the Armistice. Of that total, twelve were modified for use with Sopwith Camels (see *Flight*, April 29th, 1955, pp. 560-561).

The lighters offered a reasonable hope that it would at last be possible to make a bombing offensive against German bases in the North Sea. In order to give the flying-boat and lighter crews practice in this new technique, however, it was decided that the aircraft should first be employed on extended reconnaissance flights over the Heligoland Bight; and plans for these operations were drawn up in February 1918.

The first operational trial was made on March 19th, 1918. At 5.30 a.m. three flying boats from Felixstowe air station were towed on lighters to a point off the German coast; presumably the lighters were three of the four prototypes. The boats were airborne at 7 a.m. and maintained their reconnaissance patrol until 8.30 a.m., when they were attacked by two enemy seaplanes from Borkum. One of the German machines was shot down in flames; the other fled. The flying-boats continued their patrol. For an hour Capt. Magor, U.S.N., flew his aircraft on one engine whilst his flight engineer, Anderson, battled against the airstream to repair the other, which had been damaged in the fight. Despite his complete exposure to the gale and a lack of handholds, Anderson achieved the near-impossible and the engine was re-started some 200 miles out from Felixstowe. As was intended, the three boats flew back to their base.

The operation was repeated on March 21st, and thereafter the lighter-borne Large Americas made several successful flights. The original plan for bombing German naval bases was abandoned in July 1918: it had proved impossible to provide reliable forecasts of the weather over the North Sea, and by then landplanes such as the Handley Page V/1500 were in prospect, with a potential ability to attack the enemy from aerodromes in France.

As the year 1918 advanced, the big flying-boats fought an increasing number of engagements with the enemy fighting seaplanes. After enemy successes on April 25th and May 30th, 1918, the Germans made some transparent attempts to lure British aircraft into their waters, with the obvious intention of attacking in force once the trap had been sprung. Capt. Robert Leckie suggested that a squadron of five flying-boats should "go over and deal with the situation in the appropriate manner"; this suggestion won the ready agreement of Lt-Col. C. R. Samson, O.C. 73rd Wing.

On June 4th, Leckie led a force of four F.2As and a single Curtiss H.12 on an offensive patrol towards the Haaks Light Vessel. Two of the F.2As, N.4289 and N.4295, were from Great Yarmouth; the F.2As N.4302 and N.4533, and the H.12 No. 8689, came from Felixstowe. After two and half uneventful hours N.4533 was forced down with a broken petrol feed-pipe, and its pilot, Capt. R. F. L. Dickey, had no choice but to taxi to Holland, where he burned his aircraft. Five enemy seaplanes appeared, but seemed more anxious to shoot up the lame duck on the water than to try conclusions with the four remaining British machines. The F.2As and H.12 circled the labouring N.4533 until ten more German seaplanes appeared. Only the three F.2As turned to fight the numerically superior enemy force, because the H.12 (Ensign Eaton, U.S.N.) had flown off in pursuit of one of the original five Germans. (The Curtiss was eventually forced down in Dutch waters and its crew interned.) Of Leckie, one of his pilots said: "He went hell-for-leather for them, and drove clean, slap-bang through the enemy formation, splitting it right up, carrying away the wireless aerial of his boat on the top plane of the lesding enemy machine."

For forty minutes the F.2As fought superbly. Two enemy machines were shot down, and it is believed that four others never returned to their bases. A broken petrol pipe sent N.4302 down on to the Zuyder Zee between Terschelling and Vlieland, but the engineer, Pte. Reid, effected a quick temporary repair which enabled the pilot (Capt. A. T. Barker) to rejoin Leckie at the Haaks. Engine trouble was also experienced by N.4289, but Capt. J. Hodson flew it on one engine while repairs were effected.

At 5.15 p.m. Leckie decided to return to base, but by that time the enemy had had enough. The victory was to the warrior boats, which landed in Great Yarmouth roads at 7.10 p.m. after one of the greatest (yet least-known) aerial battles of the war. Even N.4533, down on the water, had shot down one of the enemy. What might have happened had all five British boats been available to engage the enemy is a matter for conjecture. Leckie concluded his report with the acid observation ". . . these operations were robbed of complete success entirely through faulty petrol pipes . . . It is obvious that our greatest foes are not the enemy, but our own petrol pipes . . ."

One colourful result of this action was the decision that all flying-boats should have their hulls "dazzle painted". The chief object of this idea was to enable pilots to distinguish other machines in combat and to know the identities of their occupants, for the choice of markings was left to the individual pilots. On the Great Yarmouth boats this freedom of choice led to some gaudy and bizarre markings, but Felixstowe ultimately arrived at a more or less standard colour scheme.

The pioneer in this matter had been Capt. Hodson, whose F.2A (N.4289) "was terrible in appearance, painted post-box red, with yellow lightning marks running diagonally across her . . . he fondly hoped that this would put the wind up the Hun". It it doubtful whether Hodson's colour scheme contributed directly to the defeat of the enemy on June 4th, but it certainly enabled his comrades to identify his aircraft immediately and positively, and set a fashion for flying-boats which endured until the Armistice.

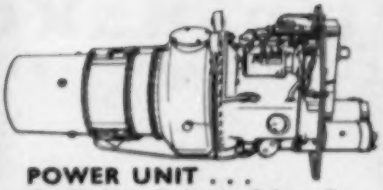
In continuation of experiments with hydrophones which had begun as early as the beginning of 1915, a few Large Americas flying-boats were equipped with the instruments. Others were later similarly equipped, but the development of a promising device was prevented by shortage of flying-boats (their numbers barely sufficed for normal patrol duties) and the need to stop the engines while listening for submarines, with the attendant uncertainty of restarting them.

In 1918, an F.3 was used at the Isle of Grain to test an automatic landing device invented by Maj. A. Q. Cooper. This consisted of a long arm which trailed below the aircraft in flight and was connected to the pilot's control column by an elastic linkage. The aircraft was flown at a shallow gliding angle, and when the trailing arm struck the water its movement was transmitted to the control column in such a way that the flying-boat flattened out. Ultimately, successful landings were accomplished with the device.

An F.3 was also used in tests with servo-operated flying controls.

(To be concluded)

THE *FAIREY* ULTRA-LIGHT HELICOPTER



POWER UNIT . . .
One Blackburn-Turboméca Palouste Gas Turbine

The Fairy Ultra-Light Helicopter is a communications and observation aircraft suitable for operation in any terrain: simple, transportable in a standard 3-ton truck, economical both in fuel and skilled maintenance requirements.

It carries a crew of two and its primary functions include A.O.P., Staff transport and communications, tactical reconnaissance and traffic control.

THE FAIREY AVIATION COMPANY LIMITED · HAYES · MIDDLESEX

40,000 ft. apart

Squadron Leader J. S. Fifield, D.F.C., A.F.C., by a recent successful ejection at ground level, demonstrated the capability of the latest Martin-Baker fully automatic ejection seat to bring about safe escapes near the ground at low forward ejection speeds. A further important requirement of an ejection seat lies in its high altitude performance. Martin-Baker fully automatic ejection seats are designed to bring the seat occupant safely down from the ejected altitude, stabilised and under control, to a selected altitude at which parachute deployment and separation of the occupant from the seat is automatically performed.

The altitude of the live ejection demonstrated at Chalgrove on October 25th was over 40,000 feet, and the altitude of separation 10,000 feet.

Martin-Baker

AIRCRAFT COMPANY LIMITED

The Register of British Civil Aircraft lists this handsome pre-war executive transport as a Stinson S.R.10C Reliant, powered with a Lycoming R-80-D5 engine. It is the property of the Fairey Aviation Co., Ltd.

AIRCRAFT INTELLIGENCE

U.S.A.

Convair Metropolitan 440. A new cargo /passenger version of this modified and quietened development of the 340 will have heavier floors and 10ft doors to expedite cargo handling. It will be readily convertible to the all-cargo or all-passenger configuration, or, if desired, the two may be combined.

Lockheed WV-3. This new development of the WV-2 as recently delivered to Early-Warning Squadron 4 at Jacksonville, Florida, carries meteorological equipment in addition to its electronic gear and is thus suitable for use as a "hurricane hunter" as well as a long-range radar picket. Built in is a small pressure chamber used for releasing radio sonde balloons.

Douglas C-132. The U.S.A.F. has decided to transfer development and production of this vast military transport from Santa Monica to Tulsa. Latest reported figures for gross weight is 500,000 lb. Engines will be four Pratt and Whitney T57 turboprops of some 15,000 equivalent horse power each.

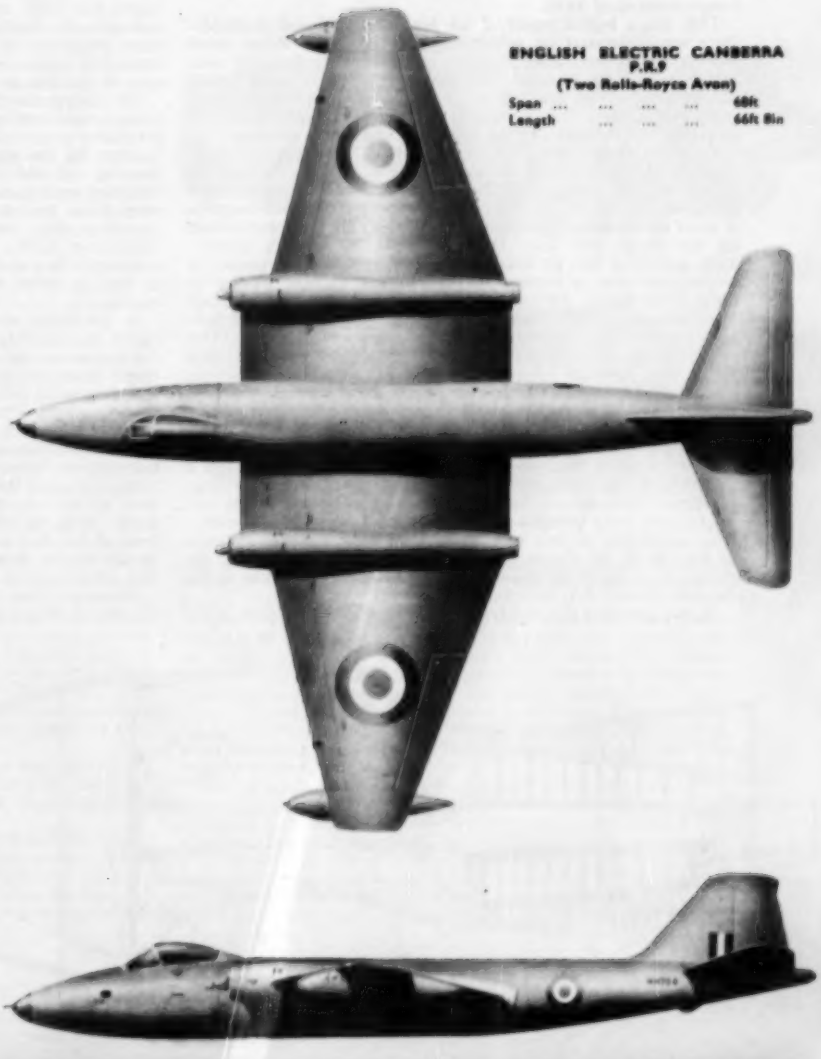
Lockheed T-33. Towards the end of next year the 5,000th Lockheed T-33 jet trainer will be delivered. The first examples of the type were flown in August, 1948. An order worth $14 million was recently placed by the U.S. Navy for a number of T2V Sea Stars (the latest T-33 development) for experimental and demonstration purposes only. This aircraft will not go into general service.

Bell X-2. Design and construction of the Bell X-2 took nine years. It has a pair of rocket motors, giving a total thrust of 15,000 lb, which can be varied by a normal throttle lever. The windscreen is heat-and-infra red ray-resistant to cope with aerodynamic heating and rays harmful to the pilot at altitudes of 100,000ft. The wings are covered in heat-resistant stainless steel and the fuselage is made of a nickel-based alloy containing copper, manganese, aluminium and silicone in addition to other classified metals. So far the X-2 has been engaged mainly on unpowered trials, but recently it made its first fully powered flight. Its powered endurance is between five and six minutes.

France

S.N.C.A.S.O. Djinn. Confirmation of an order for 50 Djinn helicopters for the French Army has just been received by S.N.C.A.S.O. This batch is additional to the pre-production machines already ordered. A recent mountain-rescue operation showed that over a distance superior to six miles "with a difference in operating levels of between 2,300 and 2,630ft," the Djinn can easily carry more than a ton of suspended load per hour.

S.N.C.A.N. Bourges Plant Activities. The 85th Noratlas twin-boom transport has now been delivered from Bourges and production rate is four a month. This will be increased to six a month next year. Tooling up for quantity production for Marcel Dassault Super Mystère wings is also being set up at Bourges, whence the first units should be delivered at the end of 1956.



ENGLISH ELECTRIC CANBERRA P.R.9
(Two Rolls-Royce Avon)

Span	...	...	...	48ft
Length	...	...	...	66ft 8in

ROLLS-ROYCE AVON

The World's Most Widely-manufactured Gas Turbine: a History of its Development

AVON is the name most frequently found among Britain's rivers; there are at least four in England and three in Scotland—and there is another in Australia. By a happy coincidence, this distribution parallels the disposition of factories at present building the Rolls-Royce Avon turbojet, an engine upon which military and civil aircraft programmes of the greatest consequence have been based and which is today more widely manufactured than any other aircraft gas turbine has ever been.

Even the legendary name of Rolls-Royce could not alone have made an engine so much in demand unless that engine was a thoroughly sound engineering achievement, capable of being relied upon implicitly. This the Avon assuredly is; and, furthermore, the basic design has shown itself capable of such development that it is already challenging the same company's Merlin piston engine for the honour of having the world's largest family of inter-related descendants. It is appropriate now to outline the manner in which this great family has evolved, and, at the same time, to describe the detail design of what can be termed the first generation of this family.

Rolls-Royce were designing axial gas turbines as long ago as the Battle of Britain; for example, the CR.1, an engine of exceptional technical interest, was on the drawing board in September 1940, and an experimental prototype ran on the test bed in 1942. The excellent Clyde turboprop incorporated another very early axial compressor, although this assembly was based on the Metrovick principle of mounting the rotor blading in axial slots in a drum extending the whole length of the compressor. In spite of this extensive axial experience—extensive in relation to that of other companies at the time—all the Rolls-Royce production gas turbines employed exclusively centrifugal compressors until 1950.

This was a logical result of the law of supply and demand: there was a demand for usable turbojets and Rolls-Royce were able to supply centrifugal engines (the Welland, Derwent and Nene) to meet the demand. But the company were never under any illusions about the relative merits of axial and centrifugal compressors, and fully appreciated that the latter would gradually give way to the more efficient axial in the fullness of time.

To illustrate this point, Dr. A. A. Griffith, the company's chief research engineer, wrote an internal paper before the end of World War II, suggesting the design of an axial turbojet of advanced conception. At that time the specific fuel consumption of most axial engines was actually inferior to the level established by the Nene and later Derwent, and Dr. Griffith accordingly proposed that an axial compressor should be designed in conjunction with a combustion system and turbine similar to those of the Nene. By "similar" he implied components designed to the same duty, with identical flow velocity, heat-release, deflection, blade velocity, pressure drop and degree of reaction. The engine would have delivered a maximum of 5,000 lb thrust and would have weighed no more than 850 lb; it thus represented a level of achievement which is only now being reached in practice. Furthermore, it showed, on paper, considerably better efficiency than the Nene.

This engine can safely be described as ahead of its time. Nevertheless, actual design work was going ahead during 1945 on a 13,000 lb-thrust turbojet employing two-stage centrifugal compression, which did not introduce any very advanced theory and might have been brought to the operational stage fairly quickly. This impressive project was intended to meet the requirements of Mr. W. E. W. Petter, who at that time was formulating the design of a light bomber—a design which finally emerged as the English Electric A.1, later named Canberra.

It was intended that the big turbojet should be mounted in the rear fuselage, so as to leave the wings free from any structural or aerodynamic compromise caused by having nacelles mounted thereon. Unfortunately, the suggested layout was not satisfactory: in particular, it necessitated the stowage of the fuel in the wings and put the bomb load in the wrong place. Moreover, the establishment of a world record for absolute speed by a Meteor in November 1945 showed that the use of wing-mounted engines was by no means disastrous from a performance viewpoint.

In the autumn of that year the Rolls-Royce engine-development establishment at Barnoldswick simply split the thrust requirement into two, and put forward a scheme for two 6,500 lb-thrust axial turbojets mounted in the wings. This was accepted as a more practical proposition by Mr. Petter, and work on the engine—known as the Rolls-Royce AJ.65—commenced at once. There was no Ministry of Supply contract in respect of this engine, which was at this time a private venture solely for the forthcoming English Electric bomber.

It was natural that, as far as possible, the design of the new turbojet should employ design principles already proven in the Nene. A comparison of the two engines shows this to a marked degree, the main shaft coupling and centre bearing being typical of the similarity obtained. Nevertheless the design thrust of 6,500 lb required a higher mass flow than that of the centrifugal engine.

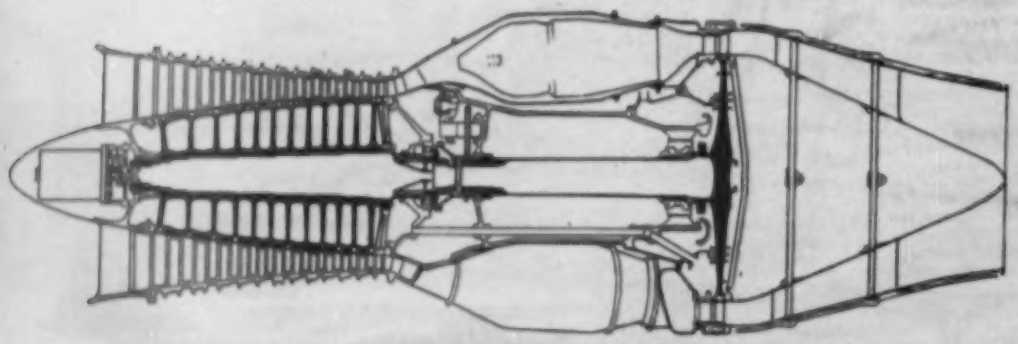
The design pressure ratio was accomplished in 12 stages.

For obvious reasons of stability it was essential to achieve considerable stiffness in the compressor casing. This could most readily be obtained by designing a casing with substantial radial depth, and Rolls-Royce elected to put circumferential stiffening ribs on the inside, the converse of usual practice. This design choice was taken owing to the fact that external ribs act as heat radiators, the significant temperature drop between the root and outer periphery of each rib resulting in unavoidable thermal stress and consequent distortion. External ribs were, however, used in the first project, as the accompanying diagram shows.

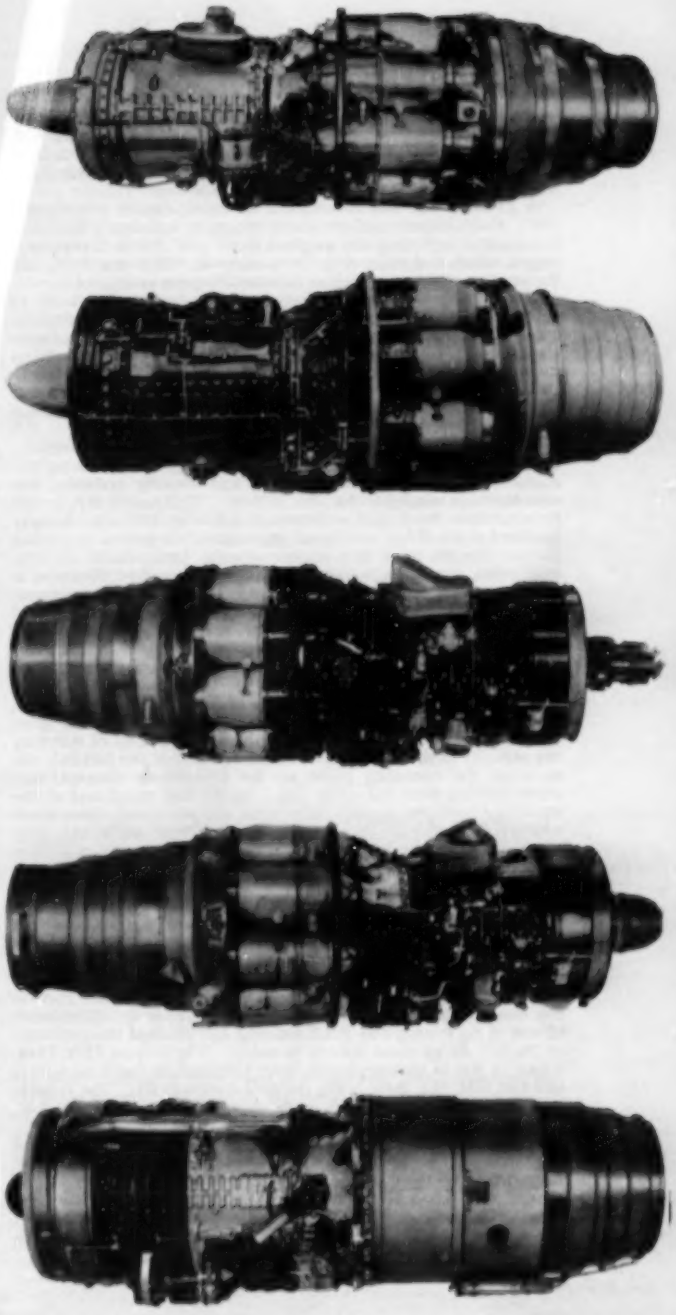
The casing was divided into upper and lower halves, each half being a sand-casting in light alloy. Included in the casting were peripheral grooves which, when machined, provided three-point location for the stator blading—a method still used, as the large drawing (pp. 904-905) shows. At the rear of the compressor the company were nearing the limit of what could be done with light alloy, from the viewpoint of loss of strength with temperature caused by the compression of the airflow. Accordingly it was decided to employ aluminium-bronze stator blading from stage nine onwards and to braze the blades together in groups of three or four in order to relieve the lip loading on the aluminium casing.

In the design of the rotor, Rolls-Royce were at great pains to evolve an assembly which would always be geometrically true to the highest degree. The basis was a steel shaft the diameter of which increased in numerous steps from the front to the rear, this dimension being always a maximum on account of whirling considerations. On to the shaft were threaded twelve light-alloy discs, one for each stage of rotor blades. The root of each disc was extended in an axial direction to form a cylindrical hub, the hub-portion of one side of the disc being precisely located on the rotor shaft and the portion on the opposite side being provided with splines engaging in corresponding driving splines on the shaft. This arrangement ensured that, even in the event of the bore of the disc growing as a result of creep, the radial growth would not be transmitted to the centering diameters; thus the disc would remain concentric to the shaft.

Alternate discs were faced in opposite directions, some pairs of discs sharing a single set of driving splines. The whole pack



This section of the AJ.65 has been drawn up from the original Rolls-Royce project g.a. drawing. Note that this pioneer engine had external ribs on the compressor casing.



Five stages in the development of the Rolls-Royce Avon. From the top: RA.2 (6,000 lb thrust, single-stage turbine); RA.3 (production engine, 6,500 lb thrust, two-stage turbine); RA.7 (production engine of increased capacity with full all-weather protection, 7,500 lb thrust); RA.21 (production engine developed from the RA.7 with rating of 8,050 lb thrust); and the RA.28 (a typical member of the second generation of Avons, with a rated thrust of 10,000 lb).

of discs and intermediate spacer rings (at the disc peripheries) were nipped in by the deflection of the front disc by a large nut forward of the front bearing, the centre of the bearing being used as a spacer, together with a washer. This axial loading greatly increased the stiffness and whirling speed of the whole assembly.

The rotor blades were so designed that they would behave as free/free members, not subject to classical first-order flapping. Fir-tree attachments—specified in the original AJ.65 project—were therefore rejected in favour of simple pinned joints through double lugs in the roots of the blades.

Two sets each of three bleed valves were fitted, the first valve of each set being connected to stages 4 and 5, the second to stages 6 and 7 and the third to stages 8 and 9.

Air entry to the compressor was through a simple intake of magnesium alloy, with six radial spars inclined to the true radial axis in order to permit greater accommodation of distortion. The initial swirl was provided by a row of fixed intake guide vanes.

At the outlet end of the compressor was bolted a compressor outlet casing, this being a light-alloy one-piece sand casting of the best aerodynamic form internally. Within this casing was mounted a wheelcase carrying a train of gears driven by a row of teeth on the compressor rear shaft. Spur and bevel gears transmitted drives to various units mounted on the outside of the delivery casing. At the rear of the compressor rotor was provided a balance piston, sealed at its outer diameter, the function of which was to balance out the axial thrusts between the compressor rotor and the turbine.

It was logical that separate, tubular combustion chambers should be chosen for the new engine, and the design of these units—which was carried out by Joseph Lucas (G.T.E.), Ltd., with Rolls-Royce co-operation—did not differ greatly from those of other Derby engines of the time. Simple geometry shows that the number of cans which can be put round an engine of given girth is a function of can diameter; on the other hand, cross-section area (the factor governing the mass flow capacity) is a function of the square of this diameter. With the basic engine configuration already settled, the optimum number of cans turned out to be eight. Only a relatively modest backbone to the engine was required, since bending moments were minimized by the four-point mounting. To provide such a backbone a cast aluminium "milk churn" was evolved, to which both the outlet casing and the nozzle box and turbine were through-bolted.

The cans were made shorter and fatter than had previously been usual, the air casing comprising front and rear portions bolted together. At the front was placed a cast burner assembly comprising a Duple burner carried from three radial struts, one strut being solid and the others acting as galleries for fuel to the main and pilot jets. The primary air scoop was arranged to be mounted on an annular periphery centred on the burner body, the reverse side of this ring also forming the location for the front of the flame tube.

Approximately 15 per cent of the total flow through each can was arranged to enter the primary scoop. This primary flow then passed through either a perforated grid or a set of swirl vanes surrounding the burner and creating a vortex to sustain the flame. The flame tube itself was designed as a conventional assembly in Nimonic 75 sheet.

A single-stage turbine was employed, attached to the rear end of the main rotor shaft, the latter being coupled to the compressor shaft by a ball-joint, transmitting axial thrust, and splines transmitting the drive. In the design of the turbine the company worked to principles already shown to be successful by the Nene. Forged blades of Nimonic 80 were secured by fir-tree roots in the rim of a very large and weighty disc of austenitic steel. In the manufacture of these discs it was standard practice to overspeed the disc to a growth in diameter of 0.2in, after which the disc would be machined back to size. The load on this large turbine rotor made the incorporation of a compressor balance piston essential, and air from the seal around this piston was fed back to the turbine.

A particular feature of the rotor blading was that each blade was fully shrouded. This was most unusual in 1946, most gas turbines at that time relying upon maintenance of minimum tip clearance.

Such were the essential features of the Rolls-Royce AJ.65, the patriarch of what is now the greatest family of gas turbines in the world. Design work on the engine actually started on September 19th, 1945; design, rig testing, component manufacture and sub-contract work (in conformity with company policy there was little of the latter at this stage) went ahead normally, and the first prototype was started up on the bed at Barnoldswick on March 25th, 1947.

Four of these original prototypes were made. By this time a Ministry of Supply development contract had been received, and the engine accordingly became known by its development rating RA.1. Construction of the prototypes was done at the Barnoldswick factory, and a proportion of the testing was also undertaken there. During the early development of the Avon it was decided to transfer Barnoldswick staff to Derby and to concentrate Avon development at the latter location. This policy was put into effect in June 1948.

The first RA.1 run lasted two hours. This time sufficed to show that the handling of the engine was unsatisfactory. A full exploration of behaviour could not be made at this stage but it was clear that at least part of the trouble lay in the compressor.

Thus did the engine of destiny get away to an inauspicious start; and it was fated to suffer many months of laborious modification before the sheer engineering ability of the company made it the eminently workable engine that it is today. So difficult

ROLLS-ROYCE AVON . . .

were its early vicissitudes that one Canberra was earmarked for the Rolls-Royce Nene, as an insurance. But the company knew that they had to go on with the axial at all costs; they had to look to the future, and they appreciated that abandonment of the Avon would have been a fundamentally retrograde step.

A 25-hour test was run with a modified engine in October, 1947, which encouraged the Avon designers sufficiently for them to consider replacing the original third and fourth compressor stages, which had meanwhile been removed. This was done, and the resulting ten-stage engine functioned quite satisfactorily.

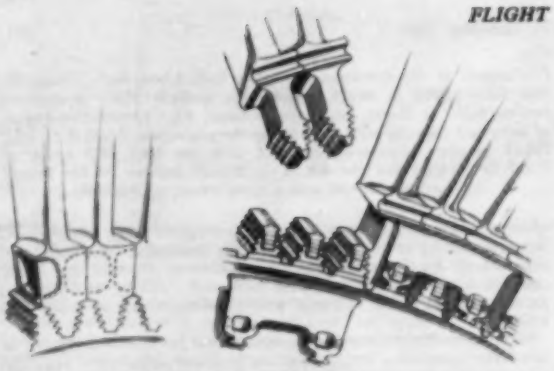
These runs at reduced pressure ratio allowed the Avon to reach quite high rotational speeds and thus permit straightforward mechanical testing of the blading. Nevertheless, the eight-stage or ten-stage engines were never looked upon as anything more than purely experimental tools. The decision was taken to produce a satisfactory interim engine in order to get the Avon to the production stage without too much delay, while the design team sorted out the problems of the future.

It was calculated that such an engine could be achieved by reducing the mass flow, and this was done by increasing the diameter of the compressor drum and thereby reducing the annulus area available for the airflow. Designated RA.2, this reduced-flow Avon had a thrust of 6,000 lb, but was virtually identical to the RA.1 in external appearance. A second important feature introduced in this engine was the provision of variable inlet swirl, to suit the variation in the optimum flow direction at the entry to the first compressor stage. This was done by mounting the 37 inlet guide vanes in plain bearings at each end and by arranging for their angle of incidence to be altered by a hydraulic ram. At first a two-position guide-vane control was employed, and such an arrangement was also fitted, retrospectively, to the RA.1s.

With three palliatives to combat compressor instability, namely, variable inlet swirl, compressor bleed and a reduced mass flow, the RA.2 proved itself a workable engine. The effect of reducing the capacity of the compressor, relative to that of the turbine, was to move the operating point on the compressor characteristic curve further from the surge line. At the low-speed end of the operating band the variable inlet swirl and the bleed valves made a great difference to the handling. The bleed ports had been incorporated in the original AJ.65 project but flow through them had been found inadequate in their original form. Modified, and used in conjunction with the two-position intake guide vanes, the bleed system was satisfactory.

Throughout 1948 the RA.2s were run intensively, the first being put on the bed in January of that year. By March a 25-hour test had been run, and a 150-hr test was successfully completed in October. Between the latter month and August of the following year no less than six 150-hr tests were run, including one on an RA.1—showing that by this time the cumulative effects of rig testing and RA.2 running had enabled the problems of the full design mass flow to be solved. On August 15th, 1948, a pair of RA.2s took to the air from Hucknall in the Lancastrian test bed VM 732, these being the first Avons to fly. The following month the same aircraft made an appearance at the S.B.A.C. flying display.

Nevertheless, trouble with the compressor persisted. The failures were by now principally of a mechanical nature, and the most frequent were associated with failures of the lug at the pinned root-fixing of the rotor blading—particularly on the first stage. The twin lugs in the aluminium-alloy blade were held in the disc periphery by a steel pin, and the combination of a high steady stress together with a superimposed vibratory stress was found to cause failures starting at stress concentrations in the hole boundary.



Intermediate form of turbine-blade root (left) as used on the RA.2 and the present form of root as employed in most production Avons up to at least the RA.7/RA.21 rating.

A large-scale photo-elastic investigation was initiated, and it was found that, by increasing the diameters of the hole and the pin, the stress concentration could be reduced. That this was an improvement is evident from the 150-hr tests already referred to. Further work led to the use of a single large lug in place of the two narrow lugs, and the pin bore was slightly relieved at the ends to accommodate pin deflections. But even this was not the final answer.

A great step forward was the discovery that, by employing electro-magnetic vibration rigs, it was feasible to load up the root in the laboratory to the full steady centrifugal load and then superimpose the live fatigue-inducing vibratory load. With such rigs Rolls-Royce succeeded in reproducing failures similar to those met in actual running. After roughly one year's work on the first-stage blading it was decided to insert a bush in the hole in the lug; various light-alloy fittings were tried, but finally a bronze bush was chosen. The bush was made a slight interference fit in the blade root, the latter being heated and shrunk on. This method proved fully effective in combating failures, and is still used.

With bushed first-stage blades it was found possible to go on to much longer periods of running, and stages other than the first began to suffer from fatigue. In the latest engine which can be described—the RA.7/RA.21 series—bushes and single lugs are fitted to all compressor rotor blades back to the fourth stage. It has also been found that it is essential to make the pins a slack fit in the bushes. By so doing, the diameters of the pins never become coincident with the local diameter of the bushes, so that the blades remain free to rock slightly.

Further difficulties encountered during development led to a new design of rear disc. This consisted of a very stiff triangulated structure formed by a pair of coned discs placed back-to-back, capable of accommodating the heavy axial load at the rim with the minimum deflection and thus making the "nip" of the compressor contribute more to the stiffness of the assembly and so improve the whirling properties. A coned 12th-stage disc could not be used, owing to the fact that the disc had to carry close-fitting seals with axial tolerances.

Avon combustion chamber, seen dismantled. The flame-tube (foreground) is located at the front by seating on the annulus around the burner assembly (lower left).

A view (right) from the rear of the complete intake casting, showing the 37 variable-incidance guide vanes at the maximum-swirl angle. They are operated by the linkage on the extreme right.

As already related, the turbine rotor blades were fully shrouded, but were otherwise similar in general design to those employed in the Nene. Early Avon trials established a tendency for the blades to crack at the root, and a partial cure was effected by welding the roots of adjacent blades together in pairs. Nevertheless it was clear that a better design could be evolved, and this materialized as an extended-root form of blade.

The revised blade was not only an attempt to eliminate turbine blade failure but was also introduced to allow the disc to run at a significantly reduced temperature. From the viewpoint of blade mechanical strength, a test programme of photo-elastic analysis and electro-magnetic vibratory rigs was used to find a root design devoid of severe stress concentrations. As in the case of the compressor blading, it was found possible to reproduce the failures experienced, and suitable blades were eventually developed.

At first each blade was made with a root of the type shown in the left-hand detail sketch opposite. From the front, such a root formed a complete gas seal, the whole flow being forced to leave between the rotor blading and so perform useful work. Nimonic alloys are poor conductors of heat, and the temperature of turbine rotor discs is therefore largely a function of the temperature of the gas or air flowing over them. This is emphasized by the high gas velocity and correspondingly high transfer ratio. By lifting the blades well clear of the disc it was found practicable to maintain the whole disc at a comparatively low temperature. This was a notable advance, for it meant that the weighty austenitic steels could be rejected in favour of ferritic steels, which are much stronger and consequently lighter for a given job.

Nevertheless, under vibrating conditions it was found that excessive stresses were set up at the edges of the webs of the box-like blade roots. The solution was to remove these webs entirely, leaving a simple, solid root with a fir-tree at its lower extremity. When inserted in the disc adjacent roots were in contact only at the disc and at the platform carrying the blade; the gap in the intervening portion was blanked off by a series of steel plates which also acted as locking members for the blades. This form of construction, which is still used, is shown in the other detail sketch.

Development of the RA.2 continued through 1949. Early in the year a semi-production batch was made, and in May a pair of engines was sent to the English Electric Company for installation in the first Canberra. Later in the year another batch was made, and some of these were sent to Canada in January of 1950 for installation in the prototype Avro Canada CF-100 fighter. Meanwhile, flight time was gradually building up, the first pair of flight engines logging 100 engine-hours between them in the Lancastrian by October 1948; and another pair put on 200 more engine-hours in the same aircraft by February 1949.

By this time the results of the various tests had told Rolls-Royce just what sort of engine they had. Altogether it was obviously going to be an outstanding turbojet; and already it was earmarked as the power unit of more new British military aircraft than all other engines together. Nevertheless, it was not yet quite as good as it could be.

Evidently the large single-stage turbine was overloaded, and the next major step in design was therefore the issue, on October 28th, 1948, of drawings for a two-stage turbine. The new turbine incorporated all the advances made with the RA.2 and introduced further improvements. One particularly remarkable fact is that, owing to the use of ferritic steel for the disc, the new two-stage turbine weighed less than did the original, massive single-stage unit.

The two-stage turbine was extensively rig-tested, the results indicating a significantly better efficiency over the whole operating range. With the new turbine fitted the Avon became the RA.3, and the rating returned to the original design figure of 6,500 lb. The first RA.3 ran on April 4th, 1949; subsequent progress was markedly superior to the pace of the first year of Avon development, for the basic engine was by this time a proven unit. By July a 25-hr test had been run; this was followed by a 150-hr test in September and the flight of one RA.3 in the Lancastrian the following month. By September 1950, this engine had logged 50 flying hours, but greater time had been recorded by engines 55 and 56 which had been airborne in Meteor 4 RA 491 since April 1950. Many readers will recall the memorable display by Harvey Heyworth in this aircraft at the 1949 S.B.A.C. display, when both Avons were extinguished together and re-lit after an upward roll; and at the 1950 display the extra urge of the RA.3 was most apparent.

In May 1951, Vickers-Armstrongs received engines 75 to 78 for the prototype Model 660 bomber, precursor of the Valiant. Before these were delivered a full type-test had been run, in November 1950.

Thus was the way cleared for quantity production, and the RA.3 engine received the appellation Avon Mk 1, and the series number 103. Tooling-up for production occupied much of 1949 and the first half of 1950, and Barnoldswick assisted by making the first five engines to production standard. The first of these was finished in March 1950. The first production engine of the main batch from Derby followed in June.

During the latter half of 1950, deliveries of engines of RA.3 rating steadily mounted. Intensive development proceeded on both the aircraft and its powerplant, and full service clearance preceded the formation of the first Canberra squadron in June 1951. This was No. 101 Bomber Squadron, based at Binbrook, Lincs, and it was the first British unit to be equipped with aircraft powered by axial gas turbines.

Meanwhile, development of the engine had been accelerated. In November 1949, a project was completed which marked a significant advance on all previous Avons, for it would have employed a 13-stage compressor and a cannular (or tubo-annular) combustion system. However, it was not built, and served as an interim study leading to other engines.

From the point of view of production, the next Avon was the RA.7. This can be described in general terms as a cleaned-up and rationalized RA.3, with an increased capacity and a rating of 7,500 lb. Other major changes introduced in this engine were strengthening of the structure to meet the requirements of high-speed (transonic) flight, deletion of the compressor/turbine balance piston, development of new starters and provision of full anti-icing. Avon RA.3s were modified to use high-energy ignition, which was a basic feature of the RA.7.

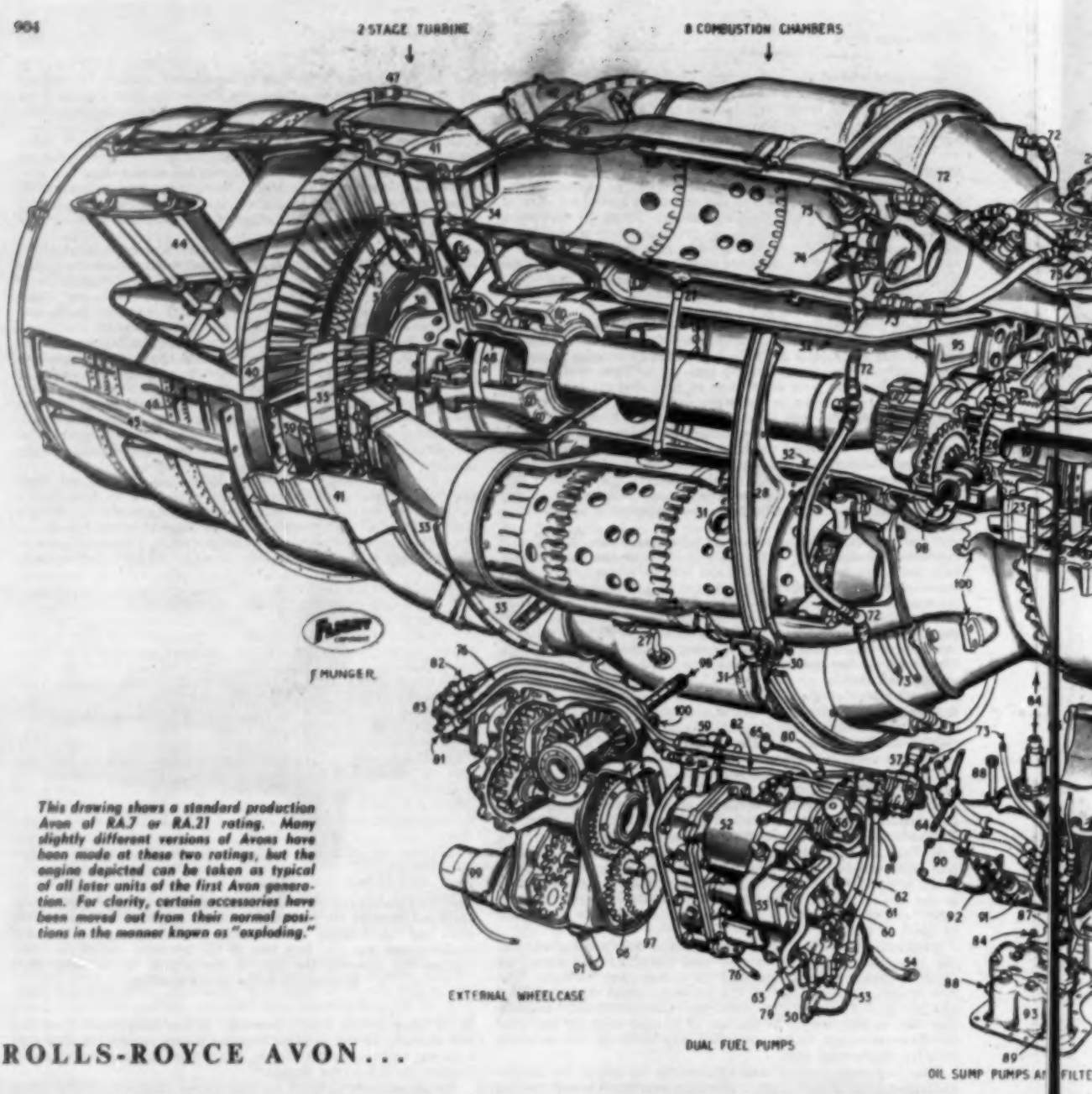
In the RA.7 (which dates from 1950) high-pressure air from the delivery end of the compressor is allowed to leak past a restrictor to the front of each turbine disc, where it provides both cooling and a rearwards axial load supplementing that due to the turbine rotor blading and approximately balancing out the forward pull of the compressor. A slight forward pull remains to be taken by the centre bearing. It has been established that the deletion of the original balance piston makes for smoother running, and this is accordingly being done as a retroactive modification on RA.3-type Avons.

The Avon compressor rotor shaft is a beautiful piece of engineering. On it are mounted the discs for the twelve stages of rotor blades, the discs and intermediate spacers being pinched up against the stiff double-coned rear disc seen here at the left-hand end of the rotor. Further left (towards the rear of the engine) is the drive shaft terminating at the centre coupling.

In the development of revised forms of starter Rolls-Royce have co-operated with British Thomson-Houston. The first series of Avons were started by a large Rotax electric motor mounted directly on the nose, under the bullet fairing, and driving directly on to the compressor. For some military engines a more rapid acceleration to idling speed was necessary, and independence of a ground electrical supply was also considered an operational advantage. The engine company and B.T.H. accordingly developed a single-breech cartridge starter, employing a cartridge of what was at that time exceptional size. Such starters also became standard on the Avon RA.3.

In order to accommodate the considerable torque applied very suddenly by such a starter, a special form of shock-damping drive was evolved. The starter turns a spring-drive shaft which extends inside the compressor to beyond the fifth stage. The rear end of this shaft is splined to an outer, final-drive shaft, which engages with the compressor rotor *via* (on the RA.7) a pawl-and-ratchet mechanism. The hot exhaust from the starter escapes through faired pipes in the intake and thence through ports in the cowling.

The RA.7 introduced a new triple-breech starter developed by Rolls-Royce but based upon B.T.H. patents. This unit is used on most of the fighter Avons at present in service. In operation it resembles the single-breech unit, but is larger, and the



This drawing shows a standard production Avon at RA.7 or RA.21 rating. Many slightly different versions of Avons have been made at these two ratings, but the engine depicted can be taken as typical of all later units of the first Avon generation. For clarity, certain accessories have been moved out from their normal positions in the manner known as "exploding."

ROLLS-ROYCE AVON...

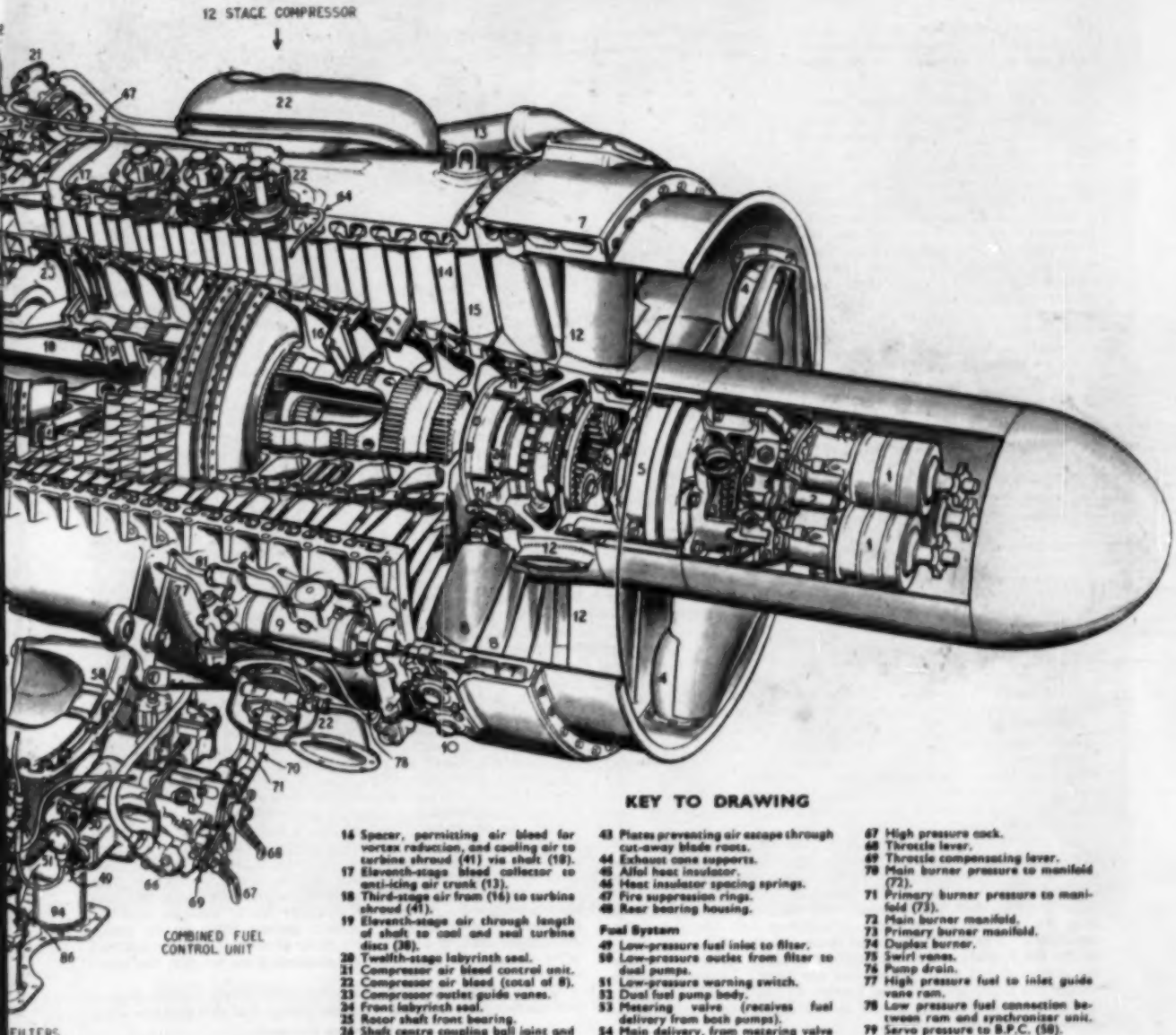
increased length of bullet fairing is very noticeable on later marks of Canberra.

Full anti-icing, another RA.7 development, was a major and obviously essential, advance. For this purpose, hot air is taken from the delivery end of the compressor and controlled by an electrically actuated Teddington sliding gate valve. This valve, when open, admits the hot air to a delivery pipe on the upper port side of the compressor casing, the forward end of the pipe opening into a circumferential manifold surrounding the intake. The air then passes radially inward through the hollow intake struts, flows through the starter fairing and finally escapes into the main stream of air entering the engine. A second exit from the circumferential manifold is provided by the hollow variable-incidence intake guide vanes. In order to allow the passage of the hot air these are now made of wrapped sheet steel; on early Avons the guide vanes were solid forgings in light alloy, with one steel master vane; later engines in this series have two master vanes.

Internal cooling air supplies gradually improved with each successive Avon model, and the RA.7 (diagram, p. 906) is typical of most engines at present in service. Most important of these supplies are those piped to the turbine discs. Full compressor delivery pressure is led to the front face of the first-stage disc, as already noted, and 11th-stage air is extracted through vortex reducers and led through the interior of the compressor and turbine shafts to cool the remaining three disc faces. The vortex reducer comprises radial vanes which increase the air pressure at the expense of velocity. Similar vanes are employed at the third compressor stage to lead off air at lower pressure for cooling the whole interior of the engine. This third-stage air cools the shafting and bearings, wheelcase and, finally, the outer casing of the turbine nozzle box. Additionally, it pressurizes the oil seal.

The two turbine discs are nipped together at their roots by a hollow-centre bolt. The rate of each disc is obtained from rig testing, and a washer pack of appropriate thickness is inserted before tightening up the whole assembly so that it will not part under gyroscopic loads. The high-pressure disc is secured to the turbine shaft by taper bolts, and torque from the bolted-on low-pressure disc is transmitted *via* cross-key dogs forming part of the inner-stage labyrinth sealing, their geometry being such as to permit radial expansion.

From the outset the Avon has employed a fuel-cooled oil cooler,



KEY TO DRAWING

Turbine Starter

1 Cartridge chamber (triple breech).
2 Relief valve (one to each chamber).
3 Turbine wheel.
4 Exhaust.
5 Reduction gear (in unit with starter).
6 Reduction gear (in unit with engine).
7 Hot-air manifold. Anti-icing air to spokes, intake guide vanes and nose bullet.

Compressor

8 Variable inlet guide vanes (hollow for anti-icing air).
9 Ram, variable-inlet guide vanes.
10 Linkage to two master vanes (8).
11 Linkage from master to remaining blades.
12 Front bearing support spokes, carrying hot air for bullet anti-icing.
13 Trunk, 11th-stage hot air to anti-icing muff, spokes and bullet.
14 Alloy stators (first three stages supported at inner ends).
15 Alloy rotor blades (last four stages bronze).
16 Spacer, permitting air bleed for vortex reduction, and cooling air to turbine shroud (41) via shaft (18).
17 Eleventh-stage bleed collector to anti-icing air trunk (13).
18 Third-stage air from (16) to turbine shroud (41).
19 Eleventh-stage air through length of shaft to cool and seal turbine discs (38).
20 Twelfth-stage labyrinth seal.
21 Compressor air bleed control unit.
22 Compressor air bleed (total of 8).
23 Compressor outlet guide vanes.
24 Front labyrinth seal.
25 Rotor shaft front bearing.
26 Shaft centre coupling ball joint and bearing assembly.

Combustion Chambers

27 Drains to collector at bottom of nozzle casing.
28 Fireproof bulkhead.
29 Expansion joint.
30 Igniter plug (in two chambers).
31 Combustion chamber interconnectors.
32 Main centre casing.
33 Nozzle-box casing.
34 Combustion-chamber outlet guide vanes.

Turbine and Exhaust Unit

35 High-pressure turbine.
36 Twelfth-stage cooling and sealing air for h-p turbine.
37 Labyrinth seal.
38 Eleventh-stage cooling and sealing air.
39 Low-pressure stators.
40 Low-pressure turbine.
41 Turbine-shroud cooling air.
42 Connector, conveying cooling air from centre casing (32) to turbine shroud (41).
43 Plates preventing air escape through cut-away blade roots.
44 Exhaust cone supports.
45 Alfol heat insulator.
46 Heat insulator spacing springs.
47 Fire suppression rings.
48 Rear bearing housing.

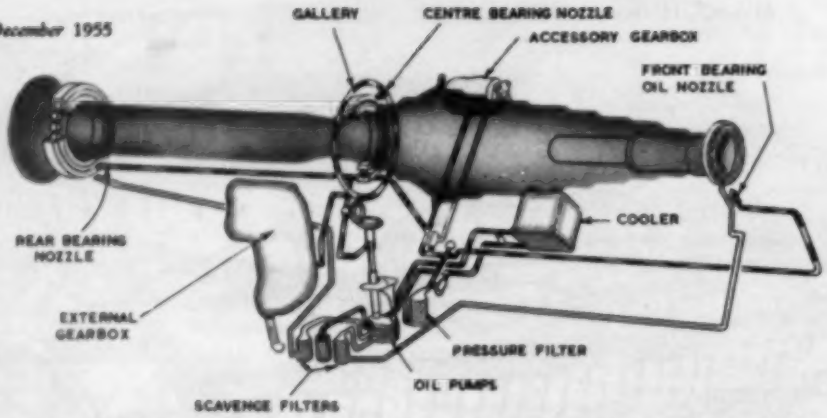
Fuel System

49 Low-pressure fuel inlet to filter.
50 Low-pressure outlet from filter to dual pumps.
51 Low-pressure warning switch.
52 Dual fuel pump body.
53 Metering valve (receives fuel delivery from both pumps).
54 Main delivery, from metering valve via oil cooler to throttle valve (66, 68).
55 Fuel pump governor.
56 Fuel pump isolating valve solenoid.
57 Acceleration control unit (connected to high, low, servo and throttle inlet fuel pressures compressor delivery, bleed valve and intake air pressures intake temperature).
58 Barometric control unit (connected to low, servo, and throttle inlet fuel pressures intake air pressure).
59 Union block (fuel).
60 Pump governor adjustment.
61 Pump high pressure delivery to A.C.U. (57).
62 Throttle inlet pressure to A.C.U. (57).
63 Delivery from upper pump to metering valve (53), lower pump delivery internal.
64 Compressor bleed valve (22) pressure to A.C.U. (57).
65 Compressor delivery pressure to A.C.U. (57).
66 Throttle inlet supply from pumps via metering valve (53) and air cooler.
67 High pressure cock.
68 Throttle lever.
69 Throttle compensating lever.
70 Main burner pressure to manifold (72).
71 Primary burner pressure to manifold (73).
72 Main burner manifold.
73 Primary burner manifold.
74 Duplex burner.
75 Swirl vanes.
76 Pump drain.
77 High pressure fuel to inlet guide vane ram.
78 Low pressure fuel connection between ram and synchronizer unit.
79 Servo pressure to B.P.C. (58).
80 Servo pressure to A.C.U. (57).
81 Ram governor pressure.
82 Low pressure supply to inlet guide vane ram governor pump (83).
83 Governor pump, variable inlet guide vane ram.

Oil System and Wheel Cases

84 Oil pump drive.
85 Drain from internal wheelcase.
86 Oil pumps, two scavenge, one pressure.
87 Oil drain de-aerator.
88 Drain from rear bearing.
89 Drain from front bearing.
90 Blank, indicating position of oil filter on other side.
91 Oil drain from external wheelcase.
92 Oil level window.
93 Scavenge filters.
94 Pressure filter.
95 Centrifugal breather, venting oil system to atmosphere.
96 Fuel pump drive gears.
97 Fuel pump drive gears.
98 Wheelcase drive from internal wheelcase.
99 Tachometer generator.
100 External wheelcase brackets.

ROLLS-ROYCE AVON . . .



The Avon lubrication system shown diagrammatically. The pressure lines are black and white; scavenge lines are plain.

the subject of a Rolls-Royce patent. Although now recognized as being in most ways a great improvement over air-cooled units, oil/fuel heat exchangers were extremely rare when the Avon was young. In the design of such units one of the principal difficulties is to ensure that no high-pressure fuel can leak into the oil. Fuel enters at the bottom of the unit, goes to a header plate and circumnavigates a matrix of tubes before passing out from the opposite corner to that at which it entered. The oil fills the free space between the cooling elements, through which it is constrained to flow in a zig-zag manner. The fuel tubing is anchored at one end only, to reduce thermal stresses, and a coffer dam is provided from which any fuel leaks can be spilled back to the low-pressure fuel filter. A by-pass is inserted to allow oil to short-circuit the cooler under low-viscosity conditions.

Developments in the combustion system have been confined to detail improvements, emphasizing the good work done by Rolls-Royce and Lucas at the outset. High-energy ignition is fitted, with igniter plugs in chambers 3 and 6.

Probably more RA.7-type Avons have now been built than any other member of the Avon family. Engines of this general type have been made at various Rolls-Royce factories, including both Derby and the Scottish group of factories. In addition, the Standard Motor Company, at Banner Lane, Coventry, the Engine Division of the Bristol Aeroplane Co., Ltd., and the Netherton, Liverpool, works of D. Napier and Son, Ltd., have all contributed to the Avon programme by manufacturing complete engines. The latter companies have now either finished making Avons or—in the case of Napier—may be through by the end of the year. Combustion chambers, in particular, have been made in thousands by specialist firms.

It is also appropriate at this point to record the intense foreign interest shown in the Avon. Licences to build have been granted to Hispano-Suiza (who have also made considerably more than 1,000 Rolls-Royce Nenes) and Svenska Flygmotor, who will shortly start production of very advanced Avons for the SAAB Lansen and J35. In Australia, Commonwealth Aircraft Corpn., Pty., Ltd., started to build an engine similar to the RA.3 at the end of 1953, and changed over to an RA.7-type Avon the following year. These Australian Avons are used in both the Canberra and Sabre as built in that country.

In 1950 the future development of the de Havilland Comet was seen to be sufficient to warrant an engine of greater thrust and efficiency than that fitted in the first version of that pioneer jet transport. The Avon was chosen, and this started off a whole new branch of the family tree with special emphasis on long life, reliability, low fuel consumption and kindred airline desiderata. The first commercial Avon was the 500-series, based on the RA.7, and rated at the original thrust of 6,500 lb, consuming a total of 731 Imp. gal. of fuel per hour. In the Avon 503, which has been fitted to the Comet 2, the thrust is raised to 7,100 lb (corresponding to the RA.25 rating) by adjusting the maximum take-off r.p.m.

Numerous detail mechanical modifications characterize the commercial Avons, but the major differences involve the use of an electric starter, increased protection against fire or ice, a high-energy ignition system instead of torch igniters, a Hardy-Spicer coupling for a shaft to a remote gearbox, provision for Rotol engine synchronization, and certain other features which may be required by operators.

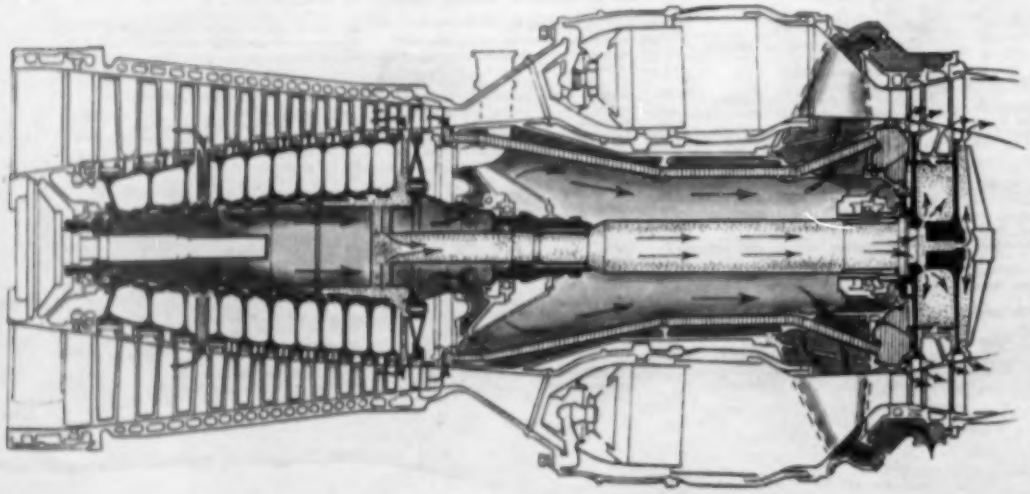
Natural development of the basic RA.7 series, stemming largely from increased service experience, has enabled Rolls-Royce to increase the rating of the basic engine to 8,050 lb, without introducing any major mechanical changes. A very large number of engines have now been made at this rating, with the Ministry of Supply designation RA.21. It is one of these which our artist has chosen to draw and it is representative of the type of engine fitted in some of our present military aircraft.

In Avon RA.3s the intake guide-vane operating ram was on the upper left-hand side, but in the RA.7 the ram is relocated on the lower right-hand side of the compressor casing. The ram is operated by high-pressure fuel. Fuel straight from the h-p pump is led to the front of the ram piston, and the rear of the piston (which is of greater effective area) is subject to servo pressure from fuel which is passed through a restrictor and spilt back to the h-p pump inlet *via* a half-ball valve. Within the guide-vane operating range, the ram position is related to engine speed by a governor pump which circulates fuel through an adjustable needle valve. As r.p.m. increase the ram moves to the rear and so opens out the guide vanes to reduce the swirl and increase the airflow.

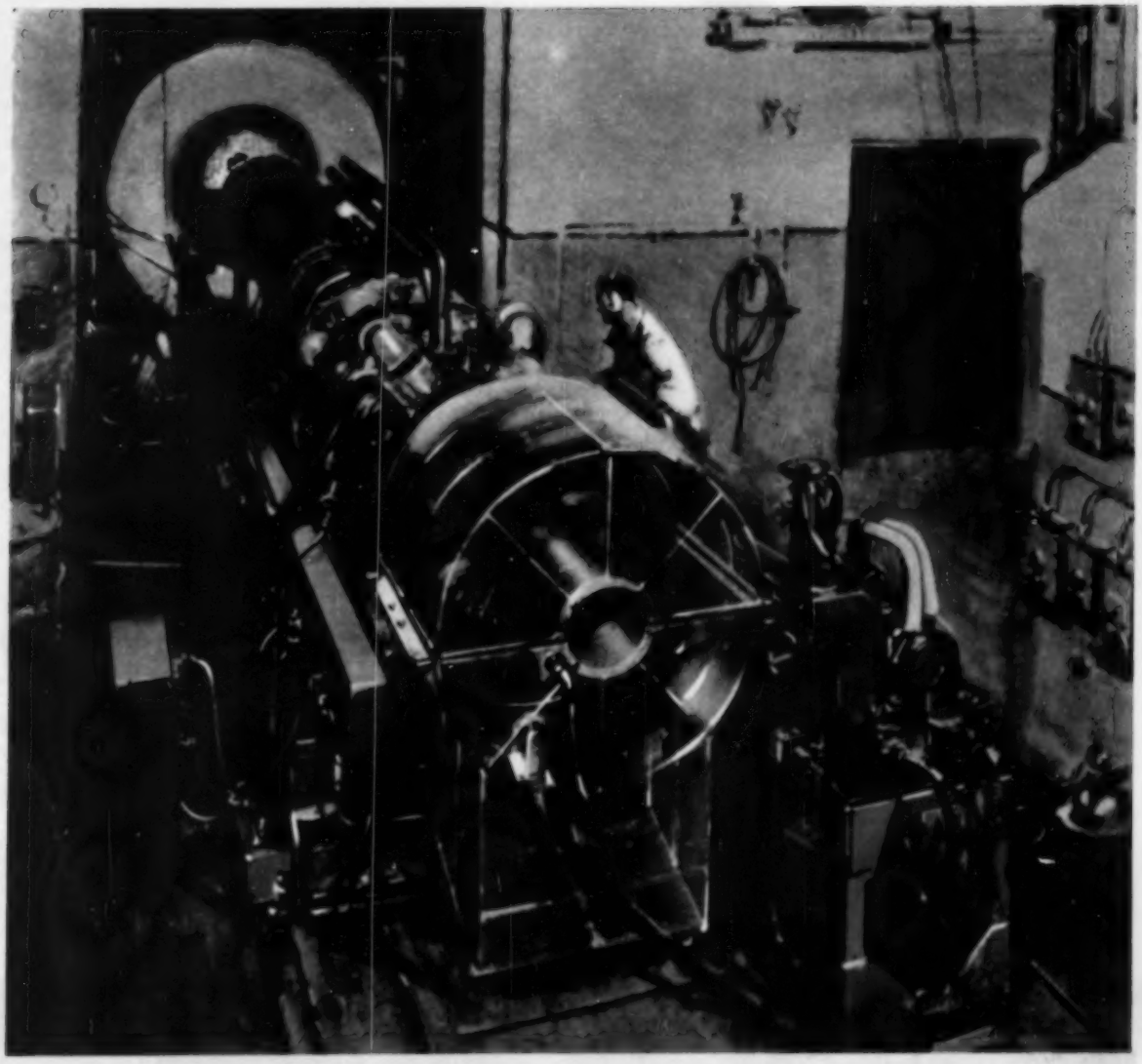
At low engine speeds the guide vanes are so set as to produce the maximum amount of swirl, and the bleed valves are open. The latter are controlled by a unit in which a piston valve directs compressor-delivery pressure to a ram which tends to close the valves, against the pull of a tension spring. The piston-operated valve is spring-loaded to close the port supplying air to the bleed valves, the piston being actuated by a half-ball valve. The latter is moved by two diaphragms of unequal area, the space between the diaphragms being connected to a venturi through which 12th-stage air is bled to atmosphere. As the engine accelerates from idling speed the venturi chokes and the inter-diaphragm pressure rises rapidly. As the two diaphragms are of unequal area the increased venturi pressure exerts a greater force on the larger diaphragm until, at a pre-set r.p.m. or pressure ratio, the half-ball valve is opened. This directs compressed air to shut the bleed valves.

All air which escapes through the bleed valves is ducted away and discharged overboard through pipes. For this purpose there

(*Concluded on page 920*)



Full compressor delivery pressure goes to cool the front face of the first-stage turbine disc; 11th-stage air cools the other three faces. Third-stage air, at lower pressure, cools shafts, bearings, wheelcase and nozzle-box outer casing.



FROM A PAINTING BY CUNEO

PORTRAIT OF AN IMPORTANT CUSTOMER

This is a painting of a Rolls-Royce Avon engine
being tested at Rolls-Royce works at Derby.
It shows one of the most astonishing pieces
of machinery in the world—
a unit, which in its latest form, for all its compactness
develops over 10,000 lb. thrust.
Shell and BP Aviation Service
congratulate Rolls-Royce on their development of the Avon,
and as suppliers of fuels and lubricants they are proud
to have been associated with this development.

Their thoughts in the sky.
Their feet on the ground.
Airmen blend courage with
careful skill.

Future perfect...

in which a young man will have satisfied his need for action and will be enjoying the security of a well-paid career

There is excitement, exhilaration, in the lift and thrust of jet flying. There is also a deep and lasting satisfaction, known only to those who fly. Ask these men to describe it and words fail. Ask them to give it up and they worry. For once you have shared the tranquillity of that new world above the clouds, you cannot easily forgo it.

Many young men dream of joining this brotherhood of flight. They sense the magic. They see that the future of mankind lies in the air and want to help fashion that future.

Present action—Future perfect

These men can realise their dream. They have within their grasp the chance of a lifetime of exciting and satisfying work. With the Royal Air Force, pilots and navigators fly often. They fly far afield. And they manage some of the finest machines in the world: Canberra, Valiant, Hunter — these names are but the prelude.

"But there's more to a life than flying" you may say. The Royal Air Force knows this and has planned accordingly.

Aircrew do much more than fly. They are often seconded for important work in Britain and abroad.

Flying Plus

Training others, international liaison, scientific exploration—these are but a few of the diverse and important missions to come the way of aircrew personnel. And the new Direct Commission scheme provides the opportunity to make the Royal Air Force a career.

You can now join, as an officer, with the certainty of a continuing and satisfying job until you retire with a pension. Or you can choose, if you wish, a twelve year commission, with the option of returning to civilian life after eight years. In this case you return with a handsome tax-free gratuity, far more than you are likely to save in a similar time in any other profession. Pay, as you rise in the service, is equally realistic. A Flight-Lieutenant of 25, drawing full allowances, can now earn more than a thousand a year.

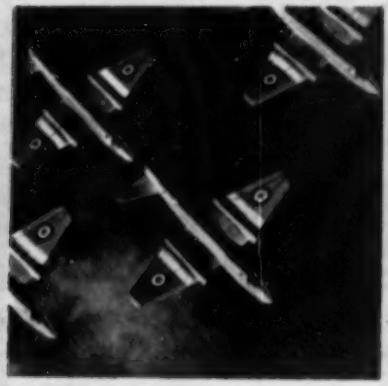
Sporting facilities in the R.A.F. are good and convenient and there is leisure to enjoy them. Travel, too, is routine, accepted and enjoyed as one of the perquisites of a vital job. It is right that this should be so. These men are our first line of defence. They are the heirs of "the few".

How to fly with the R.A.F.

Because their opportunities are great and their work important, standard of entry for aircrew is very high. Education to at least the level of the General Certificate of Education, Scottish Leaving Certificate or their equivalents, perfect physical health, aptitude as well as enthusiasm for flying — to these must be added the ability and personality to lead others. You must also be between 17½ and 26. If you have these qualifications you have the chance of a career that is both rewarding and worthwhile.

Write at once for further details of the schemes of entry and for an interesting, informative booklet on flying with the R.A.F. to the Air Ministry, (F.R. 302a), Adastral House, London, W.C.1. State date of birth and educational qualifications.

RESPONSIBILITY. Pontoons at Young Sound, Greenland, carrying stores to a Sunderland of R.A.F. Coastal Command, during the British North Greenland Expedition. A share in such exciting missions is a likely part of every pilot's and navigator's future.



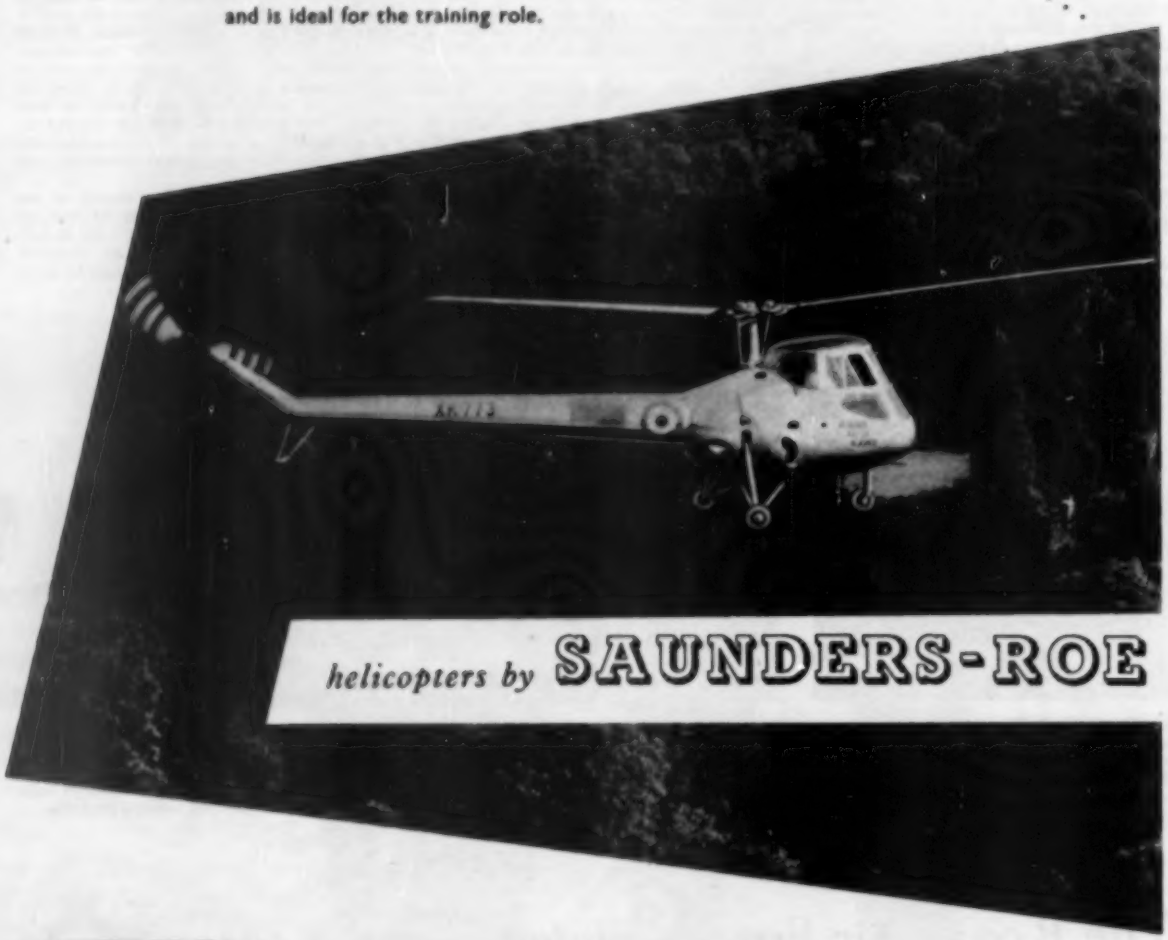
REWARD. Training to fly with the R.A.F. is exacting . . . and rewarding. It leaves you highly skilled and self-reliant, able to meet the challenge of the skies. Here, Canberra T 4 jet trainers fly in formation.

AND RELAXATION. Yachting is a popular R.A.F. pastime. Near the Baltic it's ice-yachting and gliding: across in Canada, fishing, winter sports. Wherever you go with the R.A.F. your sporting horizon expands.

The Royal Air Force *Flying ...and a career*

SAUNDERS-ROE SKEETER Mk 6 *for service with the Royal Air Force . . .*

Powered by a de Havilland Gipsy Major 200 engine, the Saunders-Roe Skeeter Mk 6 is a most economical helicopter to operate and is ideal for the training role.



helicopters by **SAUNDERS-ROE**

SAUNDERS-ROE LTD

Head Office · Osborne · East Cowes · Isle of Wight · Tel: COWES 2211 · Helicopter Division · Eastleigh · Southampton · Tel: EASTLEIGH 2731

COMMERCIAL PROGRAMME

—*or, Only Seven Shopping Days to Christmas*

"See the perfect detail and high-gloss finish."

By P. de MATANTE

IN presenting this modest feature, of pre-Christmas topicality, we would impress upon the reader that, though the veracity of the main narrative is open to considerable suspicion, the facts in the italicized interpolations come from much more responsible sources, and can be relied upon.

THIS feature comes to you by courtesy of *Flight*. Remember, only *Flight* has that real jet-age atmosphere, produced by a secret blend of printing ink and paraffin. Just the job for afterburning. Try burning this page after you've read it: you'll never regret it.

Do you know the date? You don't? Then be sure to buy an Iliffe diary. Remember, the dates to buy the family this Christmas are all in Iliffe diaries. Watch for the names on the covers—"Amateur Photographer," "The Autocar," "The Motor Cycle," "Wireless World" and "Yachting World." Packed full of useful data, their prices range from 4s 2½d to 10s 2½d, tax paid, in leather or rexine. Remember, only Iliffe diaries are good enough to record 366 happy days in 1956.

Ah, but December 2nd, 1955, was not a happy day for Basil B. Bull, public relations officer of British Imperial Airways Corporation. It brought the words he had dreaded to hear—a summons to meet his chairman, Sir Vim Wright.

For years the true state of B.I.A.C.'s operations had been concealed by the skilful distribution of charts obtained from the local fever hospital and disguised to look like payload and revenue graphs. Now, the man responsible for them had left the Corporation. Bull knew the game was up. Sir Vim had discovered that the Corporation had a perfect safety record only because nobody ever flew B.I.A.C. He would have to come clean with Vim.

His hand shook as he lit a cigarette to steady his nerves. . . .

Do your nerves need steadying? Even if they don't, make sure that, like Basil B. Bull, you always smoke the best. You can't go wrong with State Express 555, and they come in special packs for Christmas. There are colourful greetings packs of State Express 555 costing only 10s for 50 or 20s for 100; and for that extra special friend a dignified primrose and gold cabinet of 150, price 30s. Nor is that all. What better gift could there be for a man than an English hammered-pewter tankard, with a traditional glass base and containing an airtight tin of 50 State Express 555 cigarettes? Only 27s 6d for a half-pint tankard or 37s 6d for the pint size. Give the best this Christmas. Give State Express 555.

What wouldn't Bull have given at that moment to be sharing a pewter tankard or two with all the other P.R.O.s at the Aero Club? Instead, he knocked timidly at Sir Vim's door and in a second found himself wading ankle deep through carpet towards the chairman's great titanium desk.

Less than a minute later he was out again, with Sir Vim's parting burst still ringing in his ears:—

"A passenger by tomorrow, or you're fired."

Sadly he walked back to his office, past 14 of his assistant P.R.O.s and five pretty secretaries, who hardly looked up from their football pools and knitting as they chorused "Good morning, Mr. Bull" for the fourteenth time.

"What's good about it?" he growled, slamming the door of his office so hard that the bottles in his filing cabinets rattled.

"A passenger by tomorrow." What a hope. Who would fly B.I.A.C. when American Atlantic Airlines were giving everyone who flew on their pay-in-1995 family fare service an overnight suitcase containing two Cup Final tickets, a solid silver swizzle-stick and a photo of Sabrina?

You've never heard of a solid silver swizzle stick? Then write now for a Christmas catalogue from Skinner and Co., the R.A.F. jewellers. It's chock full of bright ideas. What stewardess would say "No" to a beautiful pair of gold Constellation dress clips? What wife would not powder her nose more proudly from a compact carrying a pair of R.A.F. or F.A.A. wings? What more dignified way to commemorate great flights or good fellowship than with a solid silver model aeroplane? When it's presentation, wedding, engagement, anniversary or Christmas time, it's time to visit Skinner and Co. at 35 Old Bond Street, London, W.1.

Bull lost count of time. Hour after hour he sat deep in thought.

He telephoned his friends, begging them to fill just one seat, or two seats to Brighton, only to be told: "Not if you paid us, old boy." Obviously, they had heard of the fatigue in the stairway leading to the cocktail bar in the Corporation's Stratoboosers, which had earned B.I.A.C. the name of "the tea and coffee line."

What did it matter that the Stratobooser was the safest, most comfortable aeroplane in the sky? They preferred American Atlantic, just because Ted E. Boyes, the Hammersmith Heart-throb, and all the other bobby-dazzlers were photographed on the steps of American Atlantic aircraft.

He knew that Boyes had simply climbed aboard the aircraft, dashed through its cabin and out the other side, because his agent said the million-dollar insurance on his dimples ruled out flying.

"Stunts—that's all folk are interested in," mused Bull, savagely prodding the props of a model Croydon Cargoplane that soared at an impossible angle from the ashtray on his desk.

Obviously Basil B. Bull's Cargoplane did not come from Westway Models (of 15-17 Brunel Road, London, W.3). See that you don't make the same mistake. See the perfect detail and high-gloss finish of this Westway model of the Canberra Mk8. See the grace with which it is poised on a gunmetal spiral rising from the polished walnut base. See that your models, whether mass-produced wooden giveaways or fine silver-plated trophies, are craftsman-made by Westway. Don't forget—order Westway, it's the best way.

It was the Cargoplane that gave Bull the great idea: "A stunt. Yes, that's what we want. Something to splash the initials B.I.A.C. over the front pages of the world's newspapers. Let

"What better gift could there be for a man than an English hammered - pewter tankard? . . ."

"What more dignified way to commemorate great flights . . . than a solid silver model?"

". . . inscribed in gold or colour."

"There are silk ties . . . and cuff links."

"Gold Constellation dress clips."

COMMERCIAL PROGRAMME . . .

American Atlantic keep their heart-throbs. I'll find the sort of passenger that nobody has ever carried."

A quick glance at his watch. Three o'clock.

Pausing only to grab his bowler, rolled silk umbrella and the briefcase containing his neglected elevenses, he dashed to the riverside air terminal. Not for him the 3.15 coach, with its endless 40-minute crawl to the airport. He always used the helicopter. He knew the form. With any luck he'd be able to catch the four o'clock chopper, which would deliver him to the airport by 4.20. Meanwhile, he could wait for the announcement that the helicopter was unserviceable and that he would have to go by coach.

No such message came and, at 5.15, Bull found himself climbing out of the helicopter at the airport, as fresh as if he'd just had a vibro-massage (which, in a way, he had). He made straight for the little room where B.I.A.C. pilots whiled away their off-duty months. This was the place he felt at home, because, unlike the chairman, these immaculate young men. . . .

In uniforms from Gieves, of course. All the . . . (prompter: "Not yet, you fool").

. . . these immaculate young men knew the true value of Bull.

Some months earlier, in a rash moment, he had joined the flying club run by the Corporation. After only 189 hours' dual and two prangs he had earned his wings and, although he didn't quite understand it, he felt proud of the instructor's remark that they weren't half as big as the wings he something well deserved.

Folks, Basil B. Bull may not be the world's best pilot; but he does wear the world's best flying suit. Like his helmet, goggles, gloves and flying boots, it came from D. Lewis Limited. Why not join the other happy husbands whose wives are giving them the boot this Christmas—handsome leather flying boots, lined throughout with soft luxurious sheepskin. Only £5 9s 6d a pair from D. Lewis Limited, 124 Great Portland Street, London, W.1.

As expected, Bull had no difficulty in persuading a B.I.A.C. crew to help put the Corporation back on the map, even though it meant swopping the luxurious flight-deck of a Stratobooser for the rugged cockpit of a Cargoplane.

Did somebody say "back on the map?" Here's one map you can back, safely at any time—the Foldex road map. The beauty of these productions is that they have a patented method of indexed folding which lets you open them at the bit you want without unfolding the whole affair (or, worse, having to fold it up again). Foldex maps, in various scales, cover the whole of the British Isles and the Continent, and even throw light on several parts of darkest Africa. Prices are modest: Foldex, Ltd., 45 Mitchell Street, London, E.C.1, can quote them for you—either for single maps or for quantities bearing your own publicity matter.

Soon the Cargoplane was on its way, droning hour after hour through the night on the 35-mile route to Dunstable. There, in a lorry marked "Whipsnade," waited their passenger—**the first giraffe to travel by air.**

The very neck that had enabled giraffes to look down from time immemorial on most of the animal kingdom had kept them grounded while lions, monkeys, snakes, rhinos and even elephants flew. Now, thanks to Basil B. Bull's brainwave, all that was to be changed. He had realized that if he left open the hatchway leading from the Cargoplane's big cabin to the high-set flight deck, the giraffe could stand in the cabin, with its head poked through the hatch between the co-pilot and navigator. The neck was no longer a problem.

Do you have a neck problem every Christmas? Does your favourite Aunt send you the sort of tie that looks best in the dark? Then make sure she buys her gifts at Gieves this year. There are silk ties from 24s 6d, Foulard from 18s 6d, and the world-famous Gieves Service ties from only 15s each. Don't forget that the best-dressed men go to Gieves not only for uniforms and suits, but for cuff-links, wallets, brief cases, shooting sticks and the sort of slippers that keep husbands at home by the fireside. Remember, too, that Gieves have a ladies' shop, stocking everything from perfumes to panties. Write today to Gieves, Ltd., 27 Old Bond Street, London, W.1, for a fully illustrated catalogue, full of suggestions that will solve your Christmas shopping problems.

Basil B. Bull's problems were nearly over when the Cargoplane touched down at London Airport. The secret had leaked out according to plan and he could hear the cheers of thousands of people above the noise of the Cargoplane's one good engine. Even the chairman was there to greet him. Only one person was unhappy—the air traffic controller who swore he saw a giraffe looking at him from the flight deck of a Cargoplane as it passed his office, and promptly swore off hard liquor.

This was a pity, because, although he doesn't know it, this lucky A.T.C. is going to get a set of Decoramics glasses, inscribed with his name, for Christmas. If you want to give something really novel, personal and useful, why not give the same? A wide variety of glasses and ashtrays is available, each indelibly inscribed in gold or colour with signatures, mottoes, advertising slogans or badges to your own requirements. Cost is as little as 6s for a glass or 3s to 5s for ashtrays. Full details from Decoramics, Ltd., 11B Liverpool Terrace, Worthing.

In the packed Airport lounge, Bull was far from unhappy. Countless pressmen had photographed the giraffe as it walked down the red carpet from the Cargoplane and he knew its picture would be on the front page of all tomorrow's newspapers. People would be proud to fly B.I.A.C.—the only airline that had carried a giraffe.

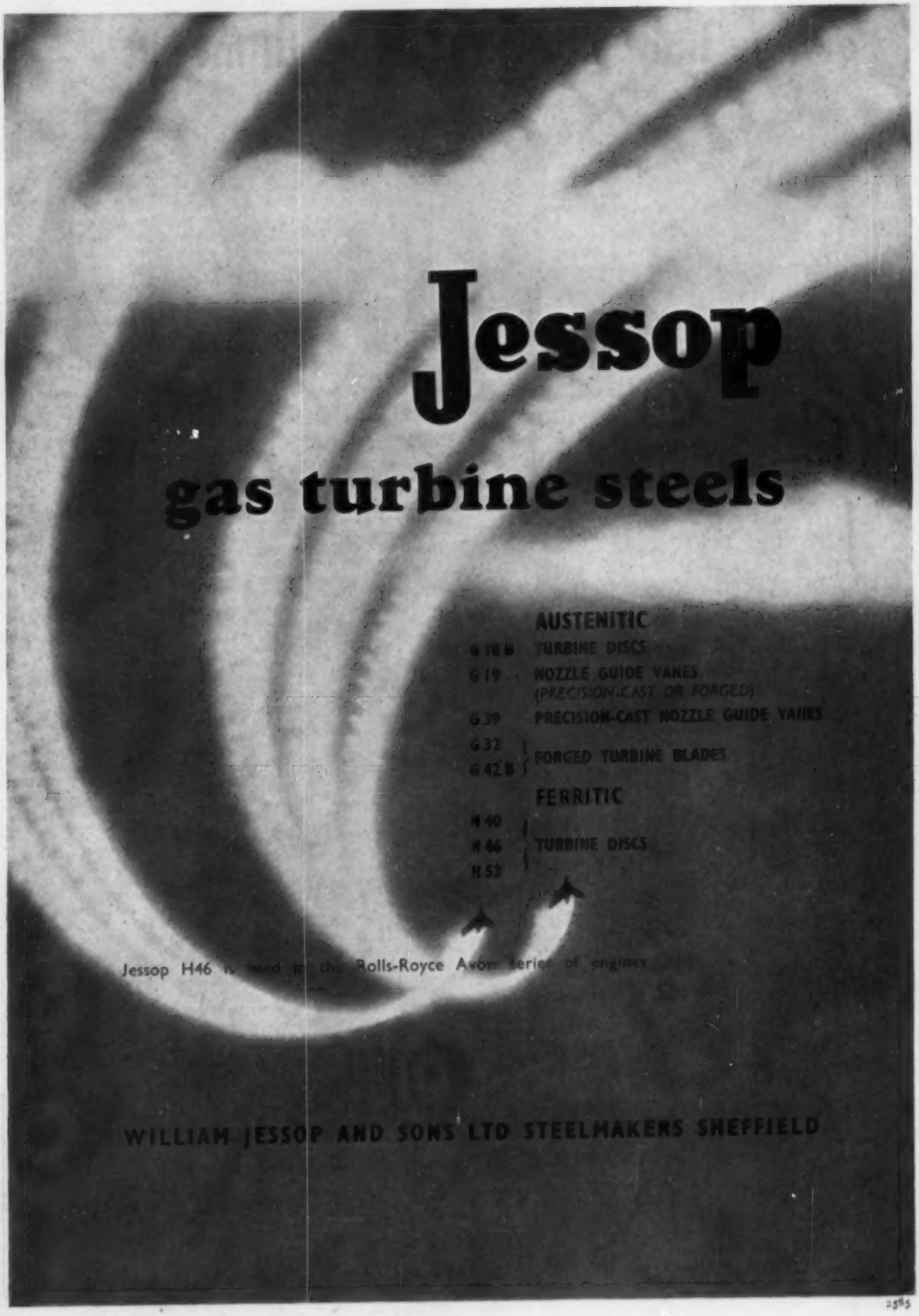
Even as he pictured the queues fighting to get into the booking centre, like opening day at the spring sales, the telephone rang. Could it be. . . ? Already?

Trembling with excitement, he lifted the receiver.

"Is that Bull? It is? Good. You know who I am. The missis is fed up with those zebra-covered seats in the car, wants something new. Could you fly over a couple of giraffes right away?"

And this is your announcer, P. de Matante, signing off. He's going home to regain his sanity by a quiet browse through "Flight Fly-Past," that wonderful portfolio of 12in × 10in reproductions of "Flight" air-to-air photographs. An ideal gift at 7s 6d (by post 8s 4d) from Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1.

". . . that wonderful portfolio . . ."


Jessop
gas turbine steels
AUSTENITIC
G 18 B TURBINE DISCS
G 19 NOZZLE GUIDE VANES (PRECISION-CAST OR FORGED)
G 39 PRECISION-CAST NOZZLE GUIDE VANES
G 32 } FORGED TURBINE BLADES
G 42 B }
FERRITIC
H 40 }
H 46 } TURBINE DISCS
H 53 }
Jessop H46 is used in the Rolls-Royce Avon series of engines
WILLIAM JESSOP AND SONS LTD STEELMAKERS SHEFFIELD
2585

For fine limit fabrications in all metals - - -

AS SUPPLIED TO ROLLS-ROYCE LIMITED

- - - CLIFFORD PRODUCTS LIMITED

IMPERIAL WORKS

FRIAR STREET, WEDNESBURY

STAFFORDSHIRE, ENGLAND

A Clifford Motor Components Company

Free-flight High-speed Research

An R.Ae.S. Main Lecture at Boscombe Down PART II

CONCLUDED here is an abstract of the paper *Free Flight Techniques for High-Speed Aerodynamic Research*, by Mr. J. A. Hamilton, M.B.E., B.Sc., A.F.R.Ae.S. (who is in charge of free-flight investigations in the supersonics section of the aerodynamics department, R.A.E.), and Mr. P. A. Hufton, M.Sc. (head of the supersonics section of the aerodynamics department, R.A.E.). The lecture was delivered at the Aeroplane and Armament Experimental Establishment, Boscombe Down, on December 1st.

The first instalment, published last week, dealt principally with early developments and the recording of measurements.

In free-flight testing [the paper continued] the complexity of a model was greatly dependent upon whether or not it had to obtain information under lifting conditions. Obviously, if a stable axisymmetric test vehicle was undisturbed during its flight it would fly at zero lift. Such test vehicles were of relatively simple construction, for the rocket motor could usually be made an integral part of the structure and no disturbance mechanism was necessary. These were termed non-separating models. For those investigations where the model had to pitch (or yaw) some form of control or rocket disturbance was necessary; this, combined with the need for more design freedom in determining model c.g. positions and inertias, precluded the use of integral construction. Such models were therefore designed and manufactured as separate units and attached to one or more rocket booster motors by a simple spigot or hook which allowed the two to separate automatically when the motor had ceased to burn. The model then flew on by itself, performing its predetermined programme of manœuvres. This separating-model technique was also applied to zero-lift investigations on specific designs, which were rarely of such shape as to allow incorporation of a rocket motor.

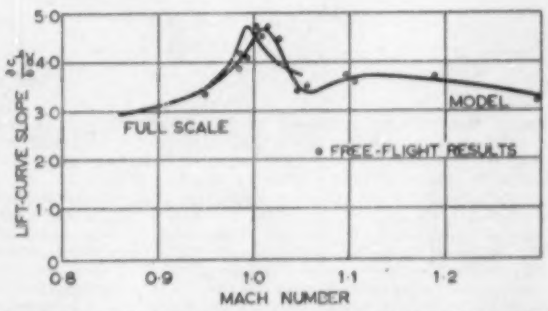
Although the separating test vehicle was the more flexible instrument, it presented two major headaches to the designer. These were the associated problems of ensuring that the rocket and model combination did not develop lift during the boosting period, and that the model separated from the rocket in an orderly manner. The first difficulty arose mainly from downwash on the rocket fins induced by the model wings: it could be minimized by careful choice of model position on the rocket and by having a high static margin for the combination. Good separation was achieved by ensuring that the drag/weight ratio for the model was low compared with the rocket motor and, for pick-a-back vehicles, by designing the attachment hook to lift the model clear as it moved forward. These difficulties were, in general, less severe for tandem arrangements than they were for pick-a-back; but, to avoid loss of accurately manufactured models, it was normal practice to fire a roughly made model to confirm that boosting and separation were satisfactory.

The paper went on to discuss in considerable detail tests on controls (measurement of rolling effectiveness, damping in roll and hinge moment); measurement of drag at zero lift; longitudinal stability; and measurement of drag at lift. The section dealing with measurement of drag at zero lift included a striking example of the efficacy of area rule, provided by some free-flight tests made to check the theoretical bases of the concept. Three non-separating models were flown: the first (A) was of a body of revolution whose shape was theoretically that to give minimum sonic wave drag for certain fixed values of length, base area, and volume (these were determined by the need to accommodate an internal rocket motor). For the second model (B) a wing was chosen—arbitrarily—with an untapered 50 deg swept plan-form and bi-convex sections, and to this was added a body of the same length and base area as model A but so shaped that the total volume (wing plus body) and the combined (wing plus body) cross-sectional area distributions were identical with those of model A. The third model (C) had the same gross wing as model B and the same values of length, base area and total volume as A and B, but the body shape was such that the wave drag of the body alone was a minimum at sonic speeds. That is to say, if the *component* drags of B or C were considered, the wing drags were equal, but the body drag of C was less than that of B.

According to area rule, however, the sonic wave drags of A and B should be equal and less than that of C. The trends indicated by the theory were closely confirmed by the experimental drag curves.

These results demonstrated also that drag tests on components of specific aircraft designs might be valueless and that the only reliable test was one on a complete model of the aircraft. This could be done by use of the separating-model technique. An added advantage of flying a complete model was that engine intake and ducting could be simulated: the internal dimensions of the duct were usually chosen to give a choking entry Mach number appropriate to some "average" engine and flight condition. In this way the effects of the inlet shock wave on the surrounding surfaces might be more or less correctly simulated.

Although the area rule had revolutionized the approach to the overall design of low-drag wing and body combinations, it did not absolve the designer from his responsibility for good detail design: apart from anything else, the area rule took no account of viscous phenomena. An example of the need for good detail design was the shaping of a cockpit-canopy windscreen to achieve a suitable compromise between good vision and low drag. To measure the effect of such minor variations in free-flight, a simple airborne balance had been devised* which recorded the drag of the component in question directly. In one investigation the aim was to measure the variation of windscreen drag with angle of slope and vee. To do this two identical canopies were mounted on a rigid box structure which was attached to the main body of the test vehicle by leaf springs. In flight, the box with its canopies and associated fairings was able to move axially relative to the main body, and the amount of the movement (i.e., the drag) was measured by a variable-inductance pick-up. The maximum axial deflection was only 0.01in, and the natural frequency of the spring system was sufficiently high to eliminate the need for internal damping. A correction had to be made for inertia effects owing to the deceleration of the test vehicle, but these were small. Two canopies were used in order to allow cancellation of normal forces.



Comparison of lift-curve slope for full-scale and free-flight model measurements.

One of the disadvantages of the free-flight technique was its inability to present a physical picture of the flow conditions causing various peculiarities in overall behaviour. Something could be done towards eliminating this disadvantage by means of pressure-distribution measurements. An obvious limitation to such a procedure was set by the relatively small number of telemetry channels available, but a certain amount of information had been obtained on wing-flow phenomena and on the effects of the boundary layer on body pressure distribution.

The pressure recovery of various engine intake configurations also fell within this category; but, because of the relatively restricted range of operating conditions which could be covered, these had tended to be no more than high Reynolds number checks on tunnel investigations. This could be of importance when the performance of the intake was likely to be seriously affected by shock-induced boundary-layer separation.

Evidence from the initial control-effectiveness tests on fixed-deflection controls showed clearly that distortion of the wings was a significant factor, particularly with wooden wings at supersonic speeds. A limited investigation was made with rectangular wings manufactured from compressed wood, light alloy and steel,

**The design and development of this unit was due to C. Kell, of the aerodynamics department, R.A.E.*

FREE-FLIGHT HIGH-SPEED RESEARCH . . .

and this confirmed that the order of the aeroelastic effect was reasonably well predicted by the theory of Broadbent. To apply this required a knowledge of the torsional characteristics of the wing and a simple test rig was constructed to obtain the torsional stiffness parameter and the locus of flexural points for every control wing flown. Torsion was applied by a pure couple at the tip of the resulting shape of the wing measured by a series of dial gauges.

The investigation of aeroelasticity by free-flight models was still in its infancy*. As with much free-flight work, the determination of the end-product was not too difficult: the difficulty was to obtain enough information to explain away the inevitable differences which arose between theory and experiment. To do this called for a knowledge of the shape of the distorted elements in flight and possibly a knowledge of the corresponding aerodynamic loading. Some progress had been achieved towards the measurement of distortions in flight by using strain-gauges, but it was too early to comment on the success of such a scheme.

The loud noises which accompanied a body flying at supersonic speeds gave rise to a plethora of explanation and speculation when full-scale aircraft first started to exceed the speed of sound. The rocket test vehicles employed in free-flight experiments had proved to be a useful means of collecting quantitative information on this subject, since they produced bangs of measurable intensity under carefully recorded conditions of flight.

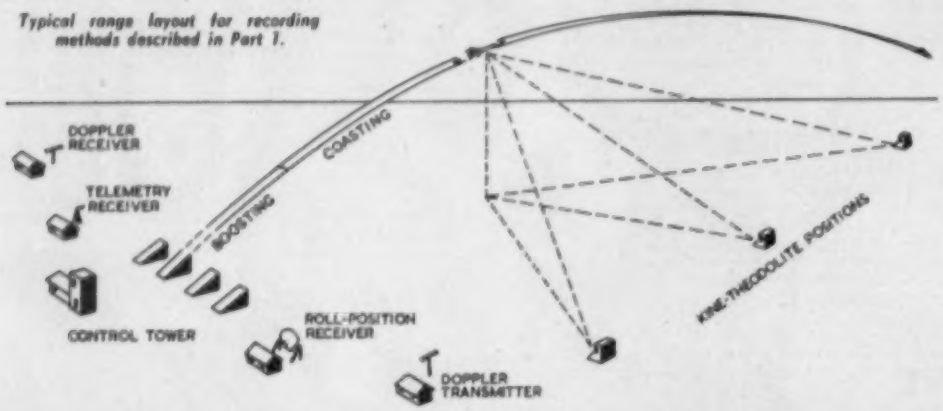
Although there was still some doubt about the precise manner in which bang intensity depended upon such things as aircraft size, altitude, height, acceleration, and so on, the basic tenet on the conditions for the occurrence of a sonic bang was now accepted i.e., that a bang was "created" when the velocity component of the vehicle towards the observer was sonic. This fact provided an explanation of a three-bang record obtained from a separating test vehicle with a maximum Mach number of about 2.0. The first bang created occurred soon after the unseparated test vehicle had reached sonic velocity; the angle subtended was then small. Because the vehicle was far away and had a large longitudinal acceleration the bang was relatively weak. The second and third bangs occurred after the rocket and dart had separated and were decelerating; these were of greater intensity, because the decelerations and distances were relatively small.

A great deal of the work done so far in free-flight had been concentrated on the transonic region, but Mach numbers of 2.5 and 3.0 were currently in use. The extension to higher Mach numbers involved no revolution in technique, though it did call for some ingenuity in the development of efficient boost systems.

One of the most interesting contemporary problems of flight at high supersonic speed was that of heat transfer and its effects on aircraft performance and structure. Development work had started on techniques to investigate heat transfer problems in free flight: preliminary indications were that, in spite of instrument and interpretation difficulties associated with the rapid changes in flight velocity, the free-flight technique would be able to contribute greatly in this field. Closely associated with heat-transfer measurement was the problem of detecting the state of the boundary layer: it was possible to go some way towards the solution of this problem by the use of static and pitot comb pressure measurements, but these were limited in scope and application and the development of more elegant methods was one of the primary tasks now in hand.

So far as stability was concerned, there was no inherent reason why the methods which had been applied to the investigation of longitudinal stability should not be applied with equal success to the lateral motion, with the proviso that certain limits in model design and flight plan were imposed to avoid undue complication of the analysis from roll effects. These tests would still be confined to zero or small lift coefficients and as had been made clear recently, the trends in design for supersonic aircraft had brought with them troubles which forced attention on the stability in conditions of combined pitch, yaw and roll. Present indications were that the accurate quantitative recording of a combined roll-yaw-pitch motion was a formidable task, but qualitative tests using simplified models on a "go" or "no go" basis looked promising.

Allied to the cross-coupling problem was the investigation of aerodynamic phenomena at high incidence, particularly those phenomena associated with vortex flows. The difficulty here arose from the high model loadings associated with high incidence tests at sea level: such tests might have to be confined to higher altitudes than those at present in use.



There were two conditions, among many others, which must be satisfied by an experimental method if its continuance was to be justified. The first was that there must be no serious impediment to the correct interpretation of the results, and the second was that the method must provide some advantage or advantages which could not be provided by alternative techniques, however much they were improved. These considerations were obviously relevant to the free-flight technique at the present time.

In the section on dynamic stability the problem of interpreting the results in terms of full-scale flight behaviour had been discussed. There were several other factors which affected the interpretation of free-flight results generally. Foremost amongst these was the effect of longitudinal deceleration. Most free-flight test vehicles had a deceleration of 5-10g during the supersonic part of their flight and 2-4g during the subsonic part. For models flying at zero lift there was nothing in the experience so far accumulated on free-flight investigations, either by specific tests or by comparison with other methods and theory, which suggested that decelerations of this order had any appreciable effect on fluid-flow phenomena. For pitching models, the evidence was scantier, but again there was nothing to suggest that the flow conditions in decelerated flight differed from those in flight at constant velocity. Intuitively, one felt that if discrepancies did arise they would occur in the mixed-flow conditions appropriate to transonic speeds. Of course, deceleration might have no effect on the flight mechanics of dynamic-stability testing. This problem had been examined by Voepel at the R.A.E., and in an unpublished paper he had shown that decelerations of order appropriate to free-flight work had but a small (< 1 per cent) effect on the evaluation of the derivatives, when the constant-speed equations of motion were applied to accelerated flight.

A more specific problem, already mentioned, was that of assessing the state of the boundary-layer in free-flight experiments. The Reynolds numbers involved were much higher than were usual in the wind-tunnel, and for large-scale models they approached those of the full-scale aircraft flying at high altitude; one was tempted, therefore, to assume that the boundary-layer and skin-friction effects were similar. For transonic speeds this assumption might not be greatly in error—although it ignored

*This statement, it was emphasized, did not apply to flutter investigations, which had been in progress for some time.

JET
Provost
(Powered by one Armstrong Siddeley Viper Turbo-Jet)
In service with the Royal Air Force
On the 21st September, 1955 a normal intake of 18 Royal Air Force Cadets, commenced flying training on the JET PROVOST at No. 2 Flying Training School, R.A.F. Hullavington.
Of the 18 Pupils 12 had had no previous flying experience whatsoever.
All 18 Cadets had flown solo by the end of October after dual instruction averaging 10 hours 35 minutes; of the 12 without previous experience the first pupil flew solo after 8 hours 20 minutes instruction, the average for this group being 11 hours 15 minutes.
That ab initio flying training on a turbo-jet powered aircraft is practicable, has been amply proved by the JET PROVOST—an aircraft capable of 300 m.p.h. in level flight yet docile and safe for the pupil.
HUNTING PERCIVAL AIRCRAFT LTD
A Hunting Group Company
LUTON, BEDFORDSHIRE, ENGLAND and at 1450 O'CONNOR DRIVE, TORONTO, CANADA

The NAPIER Eland uses NIMONIC ALLOYS

Embodying many advanced features, the Eland N.El.4 is fundamentally of simple conception and produces 4,000 E.H.P. Designed for military and civil aircraft, this single shaft turboprop consists of a ten-stage axial compressor driven by a three-stage turbine. The rapid and satisfactory progress made with the Eland design is attributed largely to the individual development of each main unit, for example, the reduction gear has been running and tested at 4,000 H.P. from the outset, rather than waiting for the complete unit to be developed up to its designed output figure. The Napier Company have planned extensive development work with the Convair 340 airliner which has been converted to take their Eland engines. An Elizabethan has also been fitted with Eland engines prior to freighter evaluation service with B.E.A. The Eland N.El.4 employs Nimonic alloys in its construction, selected for their resistance to creep, fatigue and high-temperature oxidation.

The Nimonic series of high temperature alloys are used for the rotor blades of every British aircraft gas turbine in production.

'Nimonic' is a Registered Trade Mark.

HENRY WIGGIN & COMPANY LIMITED · WIGGIN STREET · BIRMINGHAM 16

FREE-FLIGHT HIGH-SPEED RESEARCH . . .

surface-finish effects—but as flight speeds approached Mach numbers of 2.0 and above, incorrect representation of heat-transfer effects among other things would cast doubts on its validity.

With the exercise of ingenuity such problems would be overcome or circumvented in time, but this still left the more general issue of whether or not free-flight testing could justifiably be continued when large transonic and supersonic tunnels were now available. The wind tunnel was in many respects a much more satisfactory facility than was the free-flight technique: the operation of a tunnel was much less risky and inconvenient than a free-flight test; a wider range of parameters could be investigated and in much more detail; the *causes* of various aerodynamic phenomena could be more readily investigated by various flow-visualization techniques; and repeat tests on doubtful results could be made quickly and easily.

These appeared to be formidable arguments for the complete abandonment of free-flight tests, but there were equally strong counter-arguments. For example, although great advances had been made in reducing wall interference in transonic tunnels, it would be presumptuous at this stage to assume that they could be eliminated completely. Allied to this were the problems raised by the distortions necessary in some tunnel models to accommodate supports and measuring equipment. This difficulty was made more serious by the high-fineness-ratio bodies typical of supersonic aircraft; with a limitation on length set by the tunnel working section, appreciable distortions might be necessary. With low-fineness-ratio bodies distortion might still occur because of the need to avoid blockage effects. In free-flight these disadvantages were eliminated completely.

There was no rigid upper limit to the maximum Mach number which could be achieved in free flight, and the Reynolds numbers were sufficiently near full scale to eliminate most of the doubts which usually arose when tunnel results had to be interpreted in terms of full-scale behaviour. Capital cost and availability of power set a fairly well-defined limit to the combined maximum Reynolds number and Mach number which could be attained by a wind tunnel; and, once any specific tunnel had been constructed, even relatively small increases in maximum Mach number might involve extensive modifications.

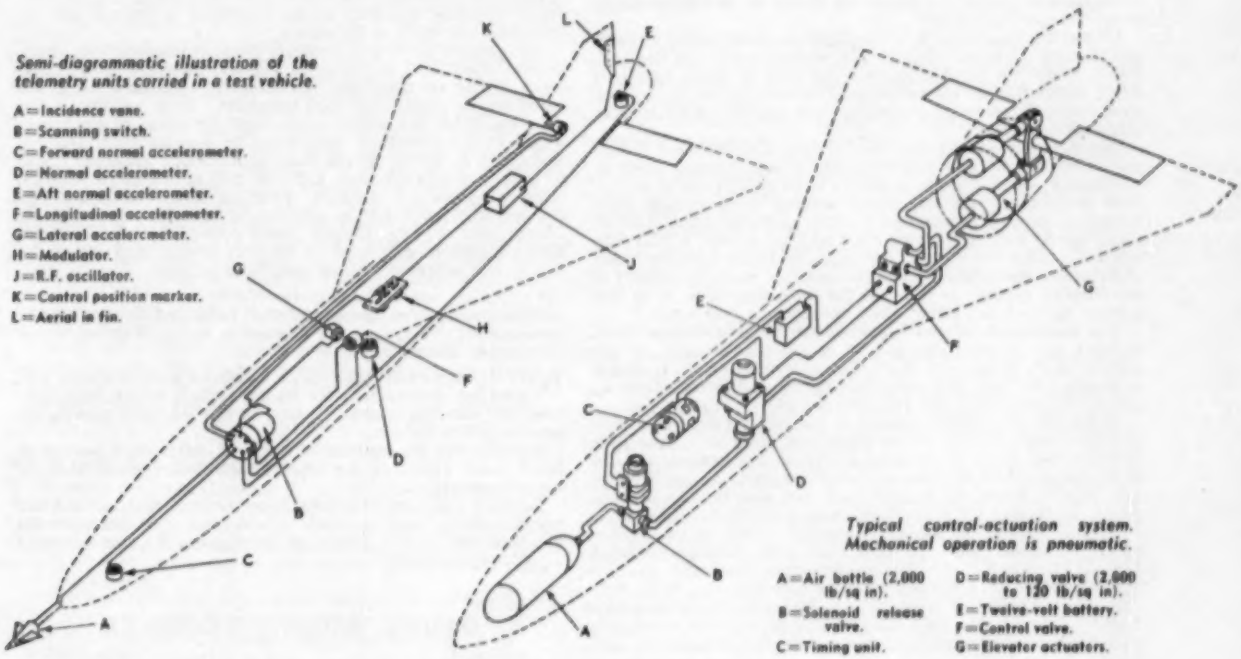
Dynamic-stability work in the tunnel at transonic and supersonic speeds was still in a rudimentary state. In spite of the ingenuity shown by designers of dynamic-stability equipment for the tunnel, the very nature of such tests implied that the constraints imposed by the test rig and the tunnel might introduce more serious errors than in the corresponding static tests. In addition, there were certain dynamic-stability experiments, e.g., those associated with inertial cross-coupling at high rates of roll, which could only be done in free flight.

Finally, there was the question of the time taken to obtain results by the two techniques. For many investigations the principal factor in deciding this was the time required for model design and construction. Considering models designed to give comparable amounts of information, e.g., lift, drag and moment tunnel models, and dynamic stability free-flight models, there appeared to be little difference in the design and manufacturing time. But for investigations where information was needed at zero-lift only, e.g., drag, intake efficiency, the free-flight test could produce an accurate and representative answer in as little as one quarter of the time required to do the corresponding tunnel test.

These arguments served to show that the tunnel and free-flight techniques were complementary and not mutually exclusive. For detailed examination of static forces and moments, for the investigation of problems requiring flow visualization, and for a great many basic research experiments as opposed to tests on specific designs, the wind tunnel was unchallengeably the superior technique. The function of free-flight testing was to obtain the limited amount of information necessary to provide a correct frame of reference for the tunnel results, to make checks on those problems where the attainment of high Reynolds number was an essential for correct flow representation, and to act as extension to the tunnel when results were required at Mach numbers beyond the tunnel limits.

Opening the discussion which followed the lecture, Mr. Handel Davies suggested that unrepresentative model manœuvre margins produced doubts concerning longitudinal stability measurements, particularly in the transonic region; and that the corrections applied to the quasi-steady theory, also, might be based on incorrect assumptions in this region. Questions raised by subsequent speakers included the relative value of intermittent-type wind-tunnels, and the possible use of free-flight techniques for investigations into the release of bombs, canopies and ejection capsules.

Internal exitation of the models, suggested by one speaker in place of the control actuation system described in the lecture, was *not* a better method, in Mr Hamilton's opinion, in view of the measurement of control effectiveness. In defence of the simulator, the final speaker in the discussion submitted that, while free-flight techniques were satisfactory for obtaining basic aerodynamic information, applied aerodynamic problems could be solved more effectively using simulators.



Semi-diagrammatic illustration of the telemetry units carried in a test vehicle.

A = Incidence vane.
B = Scanning switch.
C = Forward normal accelerometer.
D = Normal accelerometer.
E = Aft normal accelerometer.
F = Longitudinal accelerometer.
G = Lateral accelerometer.
H = Modulator.
J = R.F. oscillator.
K = Control position marker.
L = Aerial in fin.

Typical control-actuation system. Mechanical operation is pneumatic.

A = Air bottle (2,000 lb/sq in).
B = Solenoid release valve.
C = Timing unit.
D = Reducing valve (2,000 to 120 lb/sq in).
E = Twelve-volt battery.
F = Control valve.
G = Elevator actuators.

THE AERONAUTICAL BOOKSHELF

"Night Pilot," by Colonel Jean Calmel, D.F.C., Légion d'Honneur. William Kimber and Co., Ltd., 46 Wilton Place, London, S.W.1. Price 16s.

ALTHOUGH this book lacks the literary polish of earlier accounts* of war-time operations by the French squadrons of R.A.F. Bomber Command, it is a worthwhile addition to the library of war memoirs. In any case, the few shortcomings can probably be laid at the door of the translator rather than the author, because there are occasional flashes of Gallic humour and descriptive ability that outshine puzzling sentences such as: "I would tolerate no compromise with the facilities permissible in the absence of enemy aircraft."

Jean Calmel, like most of the other airmen of the Guyenne and Tunisie Groups, came to Britain in 1943 from North Africa, where he had kept his hand in on Leo 45s under the watchful eyes of the German and Italian Armistice Commissions, and then flown them as part of the Allied Air Forces in the closing stages of the Tunisian Campaign.

He was a little shaken to be sent back to school, flying Oxfords and learning the King's Regulations, when he arrived in England. Later, when his Halifax became just one of many hundreds flying without lights almost wing-tip to wing-tip in the bomber stream over Germany, he realized the vital necessity of disciplined, standardized flying.

British habits also horrified him at first. He found the R.A.F. messes strange, because they were places "where people speak in undertones, are careful not to make a noise and try not to disturb their neighbours," the sole object seeming to be to pack away several courses of unpalatable food in a few minutes. And he could hardly believe his eyes the first time he saw a W.A.A.F. rigger cranking his engine. But soon, he began adopting some of these strange habits, even to the extent of warming himself in the English manner in front of the mess fire, "that is to say, getting my backside burnt while my stomach was frozen."

The majority of the book is a much more serious account of the author's tour of operations as pilot of a Halifax bomber, an aircraft of which he was very fond. There are many excellent stories, both grim and gay, and references to encounters with German guided weapons and night intruders provide food for thought.

There are also useful statistics of the part played by the two French Groups in their eleven months of operations, from June 1944 to May 1945. They show a total of 229 missions, 14,226 flying hours, and 9,486 tons of bombs dropped. Of the 79 crews who flew in action, 42 finished their tour and 37 were brought down. Altogether 170 aircrew were posted as killed or missing.

Several died in collisions, the fear of which seems to have haunted French crews far more than some German-produced hazards. It is one of the few consolations of the atomic age that the nightmare of hundreds of invisible comrades, some only "50 yards in front, 50 yards behind, 100 yards to port and starboard" is almost certainly a thing of the past, replaced by a lonely 600 m.p.h. high-altitude flight under a sky that is almost as dark by day as by night.

"World Airline Record" Roadcap and Associates, 327 South La Salle Street, Chicago, Illinois, U.S.A. Illustrated. Price $17 50c (£6 5s).

BECAUSE of its price, *World Airline Record* is unlikely to enjoy wide public readership. It must be strongly recommended, however, to anyone with a serious professional interest in commercial aviation. This remark applies particularly to people engaged in producing civil aircraft for the world market, since this book represents a survey of the great majority of potential customers; we know of no comparable source of statistical and factual reference to the operations, traffic, organization and financial affairs of the scheduled airlines.

This new edition, the most comprehensive of the series, covers a total of 269 airlines. Information on each is presented under the following standardized headings: history and development; equipment; management; operating and traffic analysis; statistical historical summary; divisional analysis; income account; income account analysis; balance sheet; and capitalization ratios. In addition, the routes of each operator are illustrated, and in some cases maps are designed to show density of service. Further illustrations comprise 100 charts showing seasonal trends and 36 photographs of typical equipment.

The section devoted to the development of the United States airlines is an unusually compact and readable review of a sprawling subject, well supported with up-to-date statistics. The tone of editorial comment on developments outside America suggests that the compilers were less sure of their ground, and tended to rely too heavily on material supplied by operators in reply to questionnaires. There are, for example, a number of references to "so-called independents" which reflect unexpected bias towards State monopolization of air transport in non-American nations.

Except in the case of United States operators, the latest traffic figures quoted are for the calendar year 1953, or for financial years ended in 1954. The reviewer knows from personal experience the difficulties of obtaining up-to-date airline statistics; nevertheless, one feels that the publishers of *World Airline Record* would be well advised to shorten the gap between reception and publication data. It should be possible to present figures correct to December 1954 in a book published in the eleventh month of 1955. Inclusion of more comprehensive fleet data (quoting types on order as well as in service, and giving delivery dates wherever possible) would constitute a further way of increasing the value of the survey.

The chapter on Aeroflot reflects the near-impossibility, under present conditions, of obtaining full and authentic information about Soviet air transport. Estimates of Aeroflot's traffic are based on an analysis of 1950 schedules. Even so, this is the most ambitious and convincing attempt yet made, to our knowledge, at a quantitative assessment of Russian civil aviation. According to *World Airline Record*, Aeroflot's passenger traffic in 1950 was approximately equal to that of American Airlines, largest of the 34 U.S. trunk and feeder carriers. The Russian airline is credited with 1,750m passenger-miles in that year or some 22 per cent of total United States passenger traffic in 1950; Russia's population is some 25 per cent greater than that of the U.S.A. and is spread over an area twice as large.

"Construction for Aeromodellers," published by The Model Aeronautical Press, Ltd., 38 Clarendon Road, Watford, Herts. Illustrated. Price 5s.

NOT so very many years ago, a handbook dealing purely with airframe construction for model aircraft would have consisted of very few pages. Today, as this 94-pager proves, the position is very different.

Starting with the selection of tools and materials, it goes on to cover every aspect of the construction of the many airframe types in current use.

Basically a reprint of articles from *Aeromodeller*, revised and brought up to date, the book should be a wise counsellor for the beginner and a source of inspiration for the advanced designer-constructor.

OTHER BOOKS RECEIVED

Eight Baled Out, by James M. Inks. Methuen and Co., Ltd. 36, Essex Street, London, W.C.2. Price 9s 6d.

Principles of Helicopter Engineering, by Jacob Shapiro. Temple Press, Ltd., Bowling Green Lane, London, E.C.1. Price 55s.

Management for Small Traders, by John Unett, A.C.A. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 12s 6d.

Wings of the Dawn, by Eugene E. Wilson. Connecticut Printers Inc., 85, Trumbull Street, Hartford, Connecticut, U.S.A. Price $3.50.

The Foreseeable Future, by Sir George Thomson, Sc.D., F.R.S. Cambridge University Press, Bentley House, Euston Road, London, N.W.1. Price 10s 6d.

The Missing Diamond, by Captain A. O. Pollard, V.C. Hutchinson and Co. (Publishers), Ltd., 178-202, Great Portland Street, London, W.1 Price 7s 6d.

Hydraulic and Pneumatic Operation of Machines, by H. C. Town, M.I.Mech.E., M.I.Prod.E. Odhams Press, Ltd., 96, Long Acre, London, W.C.2. Price 21s.

Air Power, by Asher Lee. Gerald Duckworth and Co., Ltd., 3 Henrietta Street, London, W.C.2. Price 15s.

Rotorcraft, by Capt. R. N. Liptrot and J. D. Woods. Butterworths Scientific Publications, 88, Kingsway, London, W.C.2. Price 32s.

First Men to Fly, by Laurence Meynell. T. Werner Laurie, Ltd., 1, Doughty Street, London, W.C.1. Price 10s 6d.

*e.g., "The Happy Valley" and "Return from Hell," by Jules Roy.

CORRESPONDENCE

The Editor of "Flight" does not hold himself responsible for the views expressed by correspondents in these columns; the names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

A 100 Sqn. Pilot's Memories

YOUR article on the history of No. 100 Squadron (October 28th) had a rather more than academic interest to me, due to the fact that S/L. I. Hutcheson and myself were the only two representatives of the few survivors from the Endau raid of January 26th, 1942, present at the Standard-presentation ceremony. I was No. 2 to S/L. Hutcheson in a flight of three on the second raid, when the cloudless sky enabled the Japanese Zeros to make mincemeat of us before we got near the target.

My admiration and affection for the Vildebeeste, which continued to remain airborne despite the punishment it took, has not faded to this day. My aircraft was written off after landing back at base, as it would have been an uneconomical proposition to repair it. My air gunner had his leg blown off at the knee, but survived three and a half years' captivity in a Jap prison camp.

Your article also mentions the last two remaining Vildebeestes flying out of Java in an attempt to escape. I was in one of them, and our bad luck in running out of fuel right opposite one of the few large towns on the west coast of Sumatra, and bristling with Japanese, certainly led to our eventual capture.

Incidentally, you state that, "At about this time one Vildebeeste is said to have carried no fewer than 18 people simultaneously in an evacuation flight." I have no knowledge of such a flight; and although the aircraft could have lifted the weight without the slightest effort, I find the possibility of compressing 17 people into the tiny rear cockpit built for two a trifle hard to swallow. The two aircraft which took part in that last flight carried four people in each. One of them, with two members from each of Nos. 36 and 100 Squadrons, was forced down some considerable distance from the coast, and only one occupant survived. Sgt. Melville, after terrible privation in the water due to exposure, fatigue and thirst, was finally washed ashore the next day in a delirious condition, to be picked up by the natives and handed over to the Japanese.

The aircraft in which I travelled had three members of No. 100 and one from No. 36. We all survived the ditching, the swim to shore, and a Japanese prisoner-of-war camp.

Royal Air Force, Hornchurch. T. R. LAMB, S/L.

Whitehead and the Wrights

THE letter from Mr. Garwood in your issue of November 25th mentions the flights of Gustave Whitehead in 1901-2. These flights can only be considered as mythical, as Whitehead made no attempt to establish his claim during the years the Wrights were flying their power-driven machine, nor did he do any flying during that period.

The Whitehead story is a perfect example of the lengths to which interested and disinterested parties have gone in their efforts to belittle the accomplishments of the Wrights.

Southampton. L. HEATHER.

Tug Trouble

THE excellent article by Peter W. Brooks, *Tug and Glider* [in *Flight* for November 4th] must have awakened many memories. One point was, I thought, passed over rather quickly. That was the need for a clear understanding of the position at the hook-on.

At No. 1 G.I.S., Thame, and subsequently practised at 4 G.T.S., Kidlington, in 1942, the form was: (1) ground staff waggle elevator to indicate readiness to insert wire into release; (2) pilot "opens" release lever as the stick waggles; (3) ground crew insert wire and waggle elevator; (4) pilot closes release; (5) ground crew pull hard on wire. They also made a further check.

The final result was that everyone felt reasonably happy. Of course, Mr. Brooks' aircraft possibly have a different system from that installed on the Hawker Hector, Audax and Hind, with which we towed.

Was Mr. Brooks, too, not just a little alarmist about the need for really speedy action should the engine fail on take-off with glider on tow? Apart from a fairly brief period on take-off the glider surely loses its forward speed far less quickly than does a tug with engine failure. It should, in fact, tend to take the pull off the wire and so ease the tug pilot's problem.

One thing is advisable—to remind the glider pilot of the possibility of a release at take-off. At Thame I had engine failure short of the railway line whilst taking off with a Hotspur on tow. I released the cable in double-quick time and gently headed for an open field. The pupil glider-pilots were so surprised that they forgot to release their end and dragged down all the telephone wires from Aylesbury to Oxford.

They then had a grandstand view of me attempting to land a Hector on a freshly ploughed field. They landed beside me and were most comforting as, hanging upside down in a little dark world shot with red and green stars, I listened to the angry hissing noises ahead of me.

They were still shouting soothing words when, having slipped desperately out of my harness and fought off the dead weight of my parachute, I burrowed under the starboard side of the cockpit and rounded the tail to greet them on the port side.

The humour of the situation was heightened by the M.O. wading across the field to grab us all by the shoulders and, with a sidelong glance at the buried cockpit, asking us where the pilot was!

London, S.E.5. JOHN C. EDMUNDS.

"Flight Fly-past"—A Reader's Appreciation

I HAVE just received my copy of *Flight Fly-Past* and I must offer you my most hearty congratulations on a really magnificent production.

Your two cameramen deserve the highest praise for their wonderful photography; each picture is a gem.

I am sure many of your readers will agree with me that this album of really beautiful aeroplane photographs fills a long-felt want, and I, for one, look forward eagerly to the next and subsequent volumes.

St. Margarets, Middlesex. M. A. P. TUCKEY.

[This letter is typical of a number we have received. A note on *Flight Fly-Past* as a Christmas gift suggestion will be found on p. 908.—Ed.]

Quadripartite British Airliner Production?

TO the interested onlooker the present state and prospects of British long- and medium-range air transport production present a deeply disturbing picture. In these categories there have been placed, during the last few weeks, the largest orders in commercial aviation history—the lion's share of them in the United States.

Yet they are still only a nibble at the potential cake. The domestic market in the United States for civil airliners during the next ten years has been estimated to be worth £1,500 m, while the external market is thought to be not less than £1,000m. To let such a prize (or our fair share of it) slip through our fingers would be an economic calamity of the first order. Yet, unless we replace our present dithering by a firm and effective general design and production policy there is every reason to fear that this will happen. Our resources of technical skill, manpower and money are limited and we cannot afford a wide diffusion of effort on more projects than our economy will sustain. In our present circumstances we should limit ourselves to one (or, at most, two) types in each category of aircraft. The following appear to be the categories required:—

Category 1.—*A long-range pure jet transport of high subsonic speed, capable of making the direct East to West Atlantic crossing between the Western European capitals and New York.* To ignore this requirement with the Americans already in the field with two different aircraft for which operators have already signed, or are about to sign, substantial orders would be a confession of defeat. Moreover, it is hard to believe that this route will not prove a lucrative one. There is a considerable class of passengers which will always pay for the convenience or business advantage of a quicker journey. The Britannia, even if produced with B.E.25s and a high-speed wing, must inevitably be 50 to 100 kt slower. The cream of the passenger traffic will be skimmed by the faster operator.

To abandon the V.1000 on the grounds recently suggested by the chairman of B.O.A.C. (that his corporation would only need half a dozen or so) suggests that (a) B.O.A.C. do not expect a marked increase in future traffic (why not?); (b) we have no hope of selling this aircraft to any other operator (if not, why not?); (c) it could not be used economically on any other air route except the North Atlantic (there appear to be grounds for reaching a contrary conclusion).

The prototype of this aircraft is well advanced, and to throw away all the effort that has been put into it at this stage appears on the face of it to be an act of abysmal economic folly.

This decision should be reversed and every effort made to get the V.1000 airborne and into production, even if it entails shelving the Vanguard instead. After all, the DC-8 exists only as a

CORRESPONDENCE . . .

mock-up, so there is still time if we hurry. Moreover, we have the Conway by-pass engine, which should clinch the matter if we go about it in the right way. At the same time, we must have an energetic publicity and sales campaign, for it is this, allied with past reputation, that has sold the DC-8 and the Electra off the drawing board. Last but not least, we must give firm delivery dates and keep to them.

Category 2.—*A long-range turboprop transport whose slower speed is compensated by greater economy in operation.* That our contender, the Britannia, appears unbeatable must not lure us into taking things easy. The Britannia *ought* to attract the traffic now handled by piston-engined aircraft, but if its introduction into service is delayed too long there may be no piston-engined traffic left to attract. The operators of these aircraft may decide to go for the pure jet; and, once lost, the slower traffic will be hard to regain.

Category 3.—*A medium-range jet transport.* Our Comet 4 looks a winner and its comparative flexibility as regards the Category 1 pure jets should ensure it a ready market. But its production must be speeded up. It has been suggested that this should be done by scrapping the earlier Comets now being modified, but this solution is really too drastic for serious consideration, even if the Government were to foot the bill. The sooner this job is completed and the production lines cleared for the Comet 4, the better.

Category 4.—*Medium-range turboprop transports.* This category covers rather a wide field, which in the lesser ranges has already been dominated by the outstandingly successful Viscount—an aircraft whose development will ensure its position for many years to come. The makers of the Viscount now propose to cover the greater ranges with a new and larger design, the Vanguard. An outsider is apt to wonder whether this project will achieve the same success, for the following reasons: (a) the medium-range Britannia, already in production, appears to be sufficiently flexible to perform the rôle of the Vanguard with outstanding efficiency; (b) the potential New World market is likely to be catered for by the Electra, which will also be a powerful challenger elsewhere, since companies already using American aircraft will, other things being equal, continue to support the companies with which they have previously dealt. The Britannia might do the trick because its delivery dates would be ahead of those of the Electra; but the Vanguard, appearing at about the same time, would have a hard struggle. There appears to be a prima facie case for shelving the Vanguard and applying the resources set free for the forwarding of the V.1000 project.

If this policy for transport aircraft development were accepted the number of basic types of long- and medium-range turbine-engined transports in this country would be reduced to four, namely: In category (1), the Vickers V.1000; in (2), the Britannia LR; in (3), the Comet 4; and in (4), the Britannia MR for the longer stages and the Viscount for the shorter stages.

It should be within the capacity of our aircraft industry to cope with this programme. Its determined execution should give us a sound and profitable footing in the world markets.

Portsmouth, Hants. TORQUEMADA.

Squadron Colours

IN your article "Colours of the Day" [October 28th] you printed a photograph of two Hastings flying in formation and stated that they belonged to a Lyneham squadron. In actual fact only one aircraft (331) belongs to Lyneham; the other belongs to Abingdon. Secondly, the cheat line is painted blue, not black.

Over the past few months a means of identifying the squadron to which a Hastings belongs has been incorporated. This consists of a coloured diamond with a black border and with the squadron number painted in black in the centre of the diamond—except for 99 Sqn., which has a black diamond and white numbers. The diamond is painted high on the fin, and the colours are: 24 Sqn., blue; 47 Sqn., green; 53 Sqn., white; 99 Sqn., black; and 511 Sqn., yellow.

Royal Air Force, Lyneham. R. R. DOBB.

IN BRIEF

In Mr. F. H. Robertson's letter (December 2nd) on helicopter rotor practice, the sense was changed by a printing omission. The second sentence in the penultimate paragraph should have read: "Since, however, larger helicopters are likely to have several engines, a higher disc loading will be employed and a larger number of blades can conveniently be introduced."

NEW DE HAVILLAND DIRECTORS

FOLLOWING the reorganization of de Havilland Enterprise (recorded in *Flight* for November 11th) there is news of the appointment of Mr. M. G. Ash to the Board of de Havilland Engine Co., Ltd., and of Mr. C. R. Burgess to the Board of de Havilland Propellers, Ltd.

Mr. M. G. Ash, M.B.E., A.C.A., has in recent years played an important part in formulating the financial policy of the engine company, of which he has been secretary since 1946. His directorship, which dates from November 30th, comes at a time when the Gyron and Gyron Junior turbojets and the Sprite and Spectre rocket motors represent a growing source of business. Mr. Ash joined de Havilland on retirement from the Indian Army in 1945. Educated at Sedbergh, he qualified as a chartered accountant in 1936. In 1937 he was with the Calcutta office of Imperial Chemical Industries, Ltd., and on the outbreak of war he joined the Indian Army. After service in the Middle East as an intelligence officer he was later posted to General Slim's 14th Army in India and subsequently in Burma, where, as a lieutenant colonel, he was made a member of the Order of the British Empire for his work in the campaign which culminated in the recapture of Rangoon.

Mr. M. G. Ash.

Mr. C. R. Burgess.

Mr. C. R. Burgess, M.B.E., A.F.R.Ae.S., has been sales manager of de Havilland Propellers, Ltd., since July 1945. He joined de Havilland as an apprentice in 1928 and on completion of his training in 1933 he left the company to work as a licensed aircraft engineer on joy-riding and air-circus aircraft in the Channel Islands and India. In 1934 he returned to England as engineer-in-charge of Jersey Airways' fleet of D.H. 84 Dragons and later in the same year rejoined de Havilland as aircraft and engine field service engineer in South America. It was in 1935 that he joined the newly formed de Havilland Propeller Division as the first airscrew service engineer. A year later he was appointed assistant service manager. For his work during the war, when, as service manager, he was responsible for the organization of the overhaul, repair and field maintenance of de Havilland propellers at home and overseas, he was appointed M.B.E. Mr. Burgess' directorship, which dates from December 1st, comes during a period of rapid expansion of the propeller company, which as well as being engaged in the design and production of airscrews is actively concerned with the development of guided weapons, turbo-alternators, radar scanners and cold-air units.

FORTHCOMING EVENTS

Dec. 16. London Airport Inauguration by H.M. the Queen.
Dec. 16. R.Ae.S.: Section Lecture: "Airships of Today," by Lord Ventry.
Dec. 19. Elstree Flying Club: Annual Dinner.
Dec. 20. R.Ae.S.: Section Lecture: "Recent Advances in Aircraft Adhesives," by Dr. H. A. de Bruyne, M.A., F.R.Ae.S.
Dec. 21. Aircraft Recognition Society: December Forum.
Jan. 5. R.Ae.S.: Young People's Lecture: "Test Flying—Current Problems and Techniques," by W/C. R. P. Beamont, O.B.E., D.S.O., D.F.C., A.R.Ae.S.
Jan. 6. Helicopter Association: "Economic Production of Helicopters—Future Possibilities," by L. J. Harper.
Jan. 12-13. British Welding Research Association: London Meeting on Increasing Productivity by Welding.
Jan. 14. British Interplanetary Society: "Space Ship Instrumentation," by R. A. Waldron, B.A., Grad. Inst.P.
Jan. 14. Women's Engineering Society: New Year Luncheon.

R.Ae.S. Branch Fixtures (to Jan. 11th):—

Dec. 19, *Halton*, "Space Flight," by J. Humphries. Jan. 3, *Belfast*, "Accident Proneness," by Dr. J. A. Smiley. Jan. 5, *Isle of Wight*, "Noise of Jet Engines," by F. B. Greatrex. Jan. 10, *Boscombe Down*, "Fatigue—the Metallic Deathwatch Beetle," by D. C. Smith; *Bristol*, "Aerodynamics and Associated Problems," by R. F. Creasy. Jan. 11, *Manchester*, "Analogue and Digital Computers Applied to Aircraft Design," by J. Arrowsmith.

Specialists in Gas Turbine Combustion Components

Suppliers to Rolls-Royce Ltd. for the Avon Engine

The illustration shows a typical Aircraft Gas Turbine Engine. The parts shown in red and grey, comprising:

Flame Tubes, Combustion Chamber Outer Casing, Exhaust Unit, Reheat Jet Pipe Assembly

are manufactured at our Works at Southampton.

We also manufacture the following major units:

- **Front Nozzle Box Panels**
- **Discharge Nozzles**
- **Cooling Air Manifolds**
- **Annular Combustion Chambers (complete)**
- **Combustion Chamber Heat Shrouds**
- **Stator Conical Supports**
- **Outlet Branch Extension Units**
- **Bearing Housing Units**
- **Bearing Cover Units**
- **Fire Wall Units**
- **Oil Tank Units**
- **Jet Pipe Assemblies**

BRIGGS MOTOR BODIES LIMITED

SWAYTHLING, SOUTHAMPTON

HEAD OFFICE: DAGENHAM, ESSEX

Congratulations to Silver City Airways

60,000 TAKE-OFFS & LANDINGS

Congratulations to Silver City Airways for the recent award of the Cumberbatch Trophy for air safety. This magnificent achievement involves over 60,000 flights in 8 years of accident-free operation

The Bristol Freighters are all equipped with

DOWTY

LIQUID SPRING

UNDERCARRIAGES

DOWTY EQUIPMENT LIMITED · CHELTENHAM

Member of the DOWTY Group

MILES M.100 STUDENT

A Promising New Jet Trainer Under Construction at Shoreham

Head-on view of the Student fuselage under construction at Shoreham, showing the large size of the main doors, which are jettisonable. At present the machine is approximately 70 per cent complete.
"Flight" photograph

A WELCOME return to the field of aircraft design and manufacture by the well-known designers F. G. Miles and G. H. Miles has resulted in the development of a versatile and simple basic/intermediate jet trainer, the Miles M.100 Student. This aircraft, which should fly next year, has been designed for simplicity and economy, yet with the aim of providing a realistic, representative and flexible training machine. It should form a worthy successor to the Magister and the Master.

Following their successful series of pre-war racing aircraft (including the Hawk Speed Six of 1935 flown—20 years after its first appearance—by Ron Paine in this year's National Air Races), the Miles brothers were responsible for the design and manufacture of over 7,000 elementary and advanced trainers—notably the Magister and Master—between 1938 and 1946. After Miles Aircraft had been taken over by financiers in 1947, the design and manufacture of aircraft was ended by the new Board. At this time the company had some £5 million worth of business in hand, including substantial orders for the Messenger and the Gemini.

It was in 1950 that F. G. Miles decided to start again, and formed a new company based at Redhill. He was subsequently joined by his brother George, who had been chief designer to Airspeed, Ltd., where he was responsible for the production-design and development of the Ambassador and the Vampire Trainer.

The new company, F. G. Miles, Ltd., expanded and in 1952 moved to Shoreham Airport. It has specialized in prototype work, tool design and manufacture, aircraft design, and development work on structural plastics. Over 400 people are now employed by the company.

It will not surprise those who know the Miles brothers that the new company never lost interest in the design of its own aircraft. Projects have included the conversion of the Gemini into the Aries; design studies for civil and military freighter aircraft; work on the Durestos-winged Crabpot sailplane; and the rebuilding of the Sparrowhawk into the Sparrowjet light twin-jet racer.

Having kept in touch with military needs, the company decided in 1953 to build a prototype jet trainer—in accordance with Ministry of Supply requirements—as a private venture. This is the M.100 Student, a novel aircraft which at the present time is some 70 per cent complete. The Miles brothers claim it to be a completely new approach to economical and efficient training for operational jet aircraft; and the design leaves room for considerable development, in view of the long service life of training aircraft.

The first assumption, of course, was a belief in the philosophy of all-through jet training. For pilots who were eventually to fly jet-powered aircraft with tricycle undercarriages, basic flying training on tail-wheeled piston-engined machines, it was said, was time-wasting and could be dangerous. The ideal basic trainer, in other words, must be representative of operational types.

In its basic form the M.100 is a single-turbojet, dual-control trainer having flying characteristics designed to be docile yet representative of operational aircraft. The wings are swept, yet the landing speed is only 60 kts. A pilot's first impression will almost certainly be a favourable one of the well-designed cockpit. "Cabin" is a better word here, for the large car-type doors and the low sit of the machine on the ground (the cabin floor is only 18in above ground-level) make its pilot-access the best we have seen in a long time. The doors are jettisonable, giving excellent emergency exit without the need for heavy and costly ejector seats.

The position and mounting of the power unit is another novel and noteworthy feature. The standard installation consists of one Blackburn-Turboméca Marboré II mounted behind the cabin at the top of the fuselage, isolated from the cabin and structure by a steel bulkhead and plan bracing. This plan bracing forms a useful platform for powerplant maintenance; a reduction in fire-risk in addition to improved accessibility are also claimed. Structural damage in the event of an accident or wheel-up landing is minimized by the robust central keel, which is designed to absorb heavy loads and, in combination with the extremely low centre of gravity of the aircraft, should virtually eliminate overturning risks. Another major design feature is that, with wings and rear fuselage detached, the powerplant and other main items requiring maintenance can be readily moved as a single wheeled main-fuselage unit.

A more detailed description of the M.100 design is given below, and is followed by a survey of the present production position and future prospects of the aircraft.

Fuselage. The most notable feature of the fuselage design of the Student is the box keel member which runs longitudinally from the nose to the rear undercarriage frame, and around which the front fuselage structure is assembled. This keel is designed to take the main bending loads from the nosewheel, torsion loads and side loads being taken also in the floor structure. The top boom of the keel acts as a compression member, heavy angles at the bottom of the side sections picking up on the under-surface of the fuselage skin, which completes the box.

The main structural advantage of using such a keel member is to carry the nosewheel loads along the fuselage past the large door cut-outs. In addition the keel gives the aircraft an increased robustness in case of emergency landing, providing maximum strength at the bottom of the fuselage.

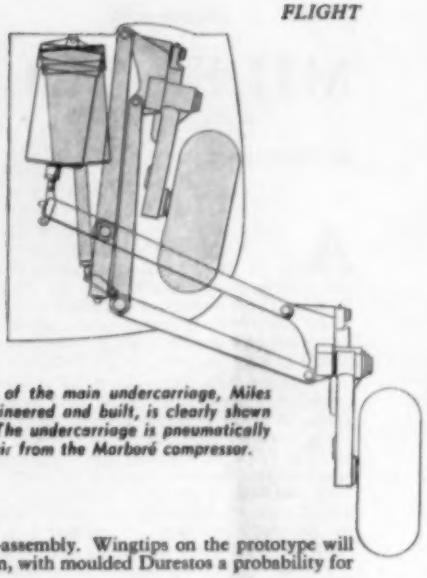
The rear fuselage, which is detachable, is of conventional semi-monocoque construction. From the transport joint between rear and main fuselage sections, the two top longerons of the latter section run forward continuously to the main-spar frame. The two lower longerons are interrupted at the main undercarriage bay, an inboard subsidiary longeron traversing this section. Main undercarriage loads are taken on two pairs of sloping frames, each tied back to the main frames, which are connected through the keel. A shear diaphragm is mounted vertically from the top of the keel to the plan bracing forming the horizontal steel firewall.

The outer structure of the main fuselage is conventional, the D.T.D. 610 skin being riveted to the frame/stringer framework. The lower skinning, below floor level, is of 24-gauge material (stressed); while the upper 26-gauge skinning is unstressed. The main-spar frame is a double unit, except for the portion above the top of the wing spar; and a continuation of the spar itself is taken across the fuselage between the vertical-pinned spar fittings. The rear-spar frame is single.

The Marboré powerplant is installed in the upper main fuselage on three mounting feet, carried on two bulkhead-type frames. The firewalls consist of a main horizontal platform beneath the engine, and the vertical front panel; there is in addition a sub-

Looking into the Student's cabin, with door fully open. The control pedestal is built-up on the central box keel.

Responsible for the design of the Student, Mr. F. G. Miles (left) and Mr. G. H. Miles have an impressive record of successful light-aircraft designs. "Flight" photograph



The retraction principle of the main undercarriage, Miles designed and Dowty engineered and built, is clearly shown in the above diagram. The undercarriage is pneumatically operated using bleed air from the Marboré compressor.

MILES M.100 STUDENT . . .

dividing partition aft of the Marboré's compressor. Air is bled from the compressor to provide the pneumatic actuation of flaps, undercarriage and dive-brakes. The air-intake ducting to the engine is of light alloy in the prototype aircraft, but the use of Durestos is envisaged for production machines. The air intake itself will be of moulded Perspex in production aircraft, giving improved upward visibility from the cabin.

In the cabin, a built-up pedestal on the central keel carries throttle, flap, dive-brake, fuel, starter, elevator trim and nose-wheel-lock controls. Production machines will have a second throttle on the port side of the cockpit, located on a built-out mounting above the upper hinge on the door frame. Flying controls are conventional and the Goodyear disc brakes are toe-operated. For ground manœuvring, the steerable nosewheel may be employed or, with the steering mechanism released, the brakes may be used. The exact layout of the instrument panel is not finalized, but for the R.A.F. the standard blind-flying panel would be centrally accommodated. The single-curvature Perspex windscreen on the prototype Student was moulded by the Triplex company. The use of laminated glass for this item is envisaged on production aircraft.

Emergency exit is made easy by the large doors, which are jettisonable by means of hinge-release handles below each end of the instrument panel. 25g seats are to be fitted, the seat harness being attached to rearward strong points. The space behind the two pilots' seats, which incorporates a raised floor, can accommodate two extra seats, additional radio or other equipment.

The control system for elevators, rudder and ailerons is similar to that of the Gemini (consisting of push-pull rods) and control runs are taken back inside the box keel.

The pneumatically operated undercarriage, engineered and manufactured by Dowty Equipment, is based on an original design put forward by Miles. It employs Dowty Liquid Spring and Levered-Suspension principles, and is fitted with Goodyear wheels and disc brakes. The retraction principle of the main undercarriage, which has a track of 7ft, is shown in the diagram on this page. The nosewheel is a development of that designed for the Fokker Promoter, and its retraction levers are mounted on the torque tube carried by the extension of the fuselage keel sides forward of the first-frame bulkhead at the nose. It retracts into the widened cut-out section of the forward end of the keel.

The segment dive-brakes are located in the triangular space between the sloping rear frame of the undercarriage bay and the rear-spar frame, and are actuated by a pneumatic ram.

The radio equipment and 24-volt battery are to be carried in the nose, respectively on top of and to starboard of the keel member. For ease of access to these items, production aircraft will be fitted with hinged upper nose panels.

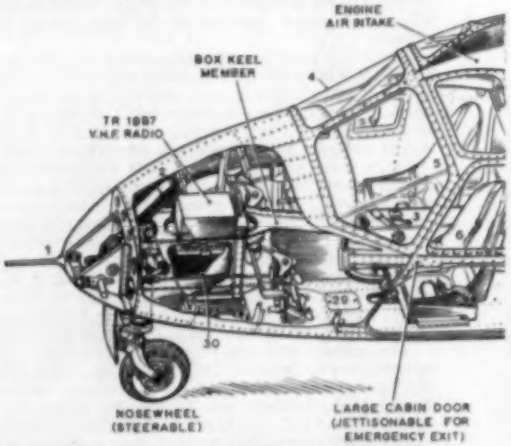
Wing. Assembly of the wing has not yet begun, although the materials and fabricated items for it are already held at Shoreham. The design of the wing incorporates a single main spar at 30 per cent chord, which carries all the wing bending loads. This spar will be of I-section, built up from pressed angles and extruded reinforcing strips which provide extra spar-boom thickness. At 70 per cent chord, the simple rear spar acts as a closing member for the wing torsion box, and carries shear loads.

The wing section is of the N.A.C.A. 230 series, having a root t/c ratio of 15 per cent. Light-gauge pressed wing ribs will be employed and, as the ribs are closely spaced, there will be no spanwise stringers. Skinning will be of D.T.D. 610 sheet. Leading-edge skinning is simply wrapped around from top to bottom of the main spar: in production machines, this section will probably be built as a separate sub-assembly. Wingtips on the prototype will be of welded aluminium, with moulded Durestos a probability for later aircraft.

Slotted flaps and Frise-type mass-balanced ailerons will be incorporated, flap actuation being achieved by a single pneumatic ram having an interconnection shaft across the fuselage. Bag-type fuel tanks are to be carried aft of and in front of the main spar, extending to the flap/aileron rib in the main section and one bay further outboard in the leading-edge section. Total fuel capacity is 100 gallons.

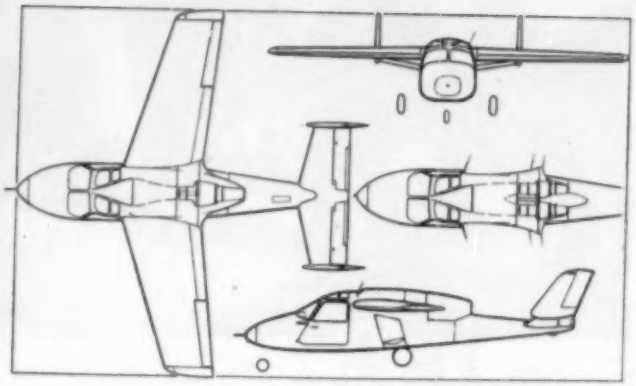
Tail Unit. The twin tail unit is of conventional construction and the tailplane has a dihedral angle of 9½ deg. An I-section spar comprising extruded L.65 T-section booms is used on the tailplane, together with a light forward spar running from the front attachment position. The elevator tabs, in addition to being electrically trimmed from the cockpit, are fitted with an anti-servo balance mechanism to give improved feel. There is mass balancing in the leading edge of the elevators and in the horn-like section of the rudders. The tailplane tip fairing outboard of the fins accommodates the rudder control linkage.

Variants and Possibilities. In addition to its basic training rôle, the Student can be used for more advanced instruction including gunnery, dive bombing and rocket-firing training. The same airframe can be adopted as a twin-jet trainer (two Palas 600s are envisaged). Other possible versions of the M.100 include a light four-seat commuter cations aircraft (still-air range with standard tanks would 450 miles); a ground-support aircraft; and (in modified form) an A.O.P. version.



The main claim made by the Miles company for this aircraft is of economy—in first cost and in operation. The relatively low first cost is attributed to simplicity in design (and light weight) and the absence of very-high-strength steels and alloys (i.e., fewer and simpler components, and materials which are easier to fabricate). The economy in operation stems mainly from the low power and economy of the Marboré powerplant.

As mentioned, the prototype Student is being built as a private venture and is at present approximately 70 per cent complete.



Manufacturing progress is governed not by the time scale of a planned programme, but by the proportion of the company's total effort which it can afford to put on to this work. Assuming the present rate of progress, however, the aircraft should be complete by May or June of next year. With financial support from the Government, Miles point out, this date could be significantly advanced.

If an order were placed, construction of two further prototypes, for development flying, would follow. For an order of 200 production aircraft, delivery would commence within 18 months of the order being placed, and the contract would be completed in approximately 13 months from delivery of the first aircraft.

The estimated basic price of the Student, assuming a quantity production of 200 machines, is £6,500, excluding powerplant and standard instruments supplied on embodiment loan procedure. Tooling for the production of 200 aircraft is estimated at £150,000, so that the airframe price including jig and tool depreciation (assuming no residual value) would rise to £7,250.

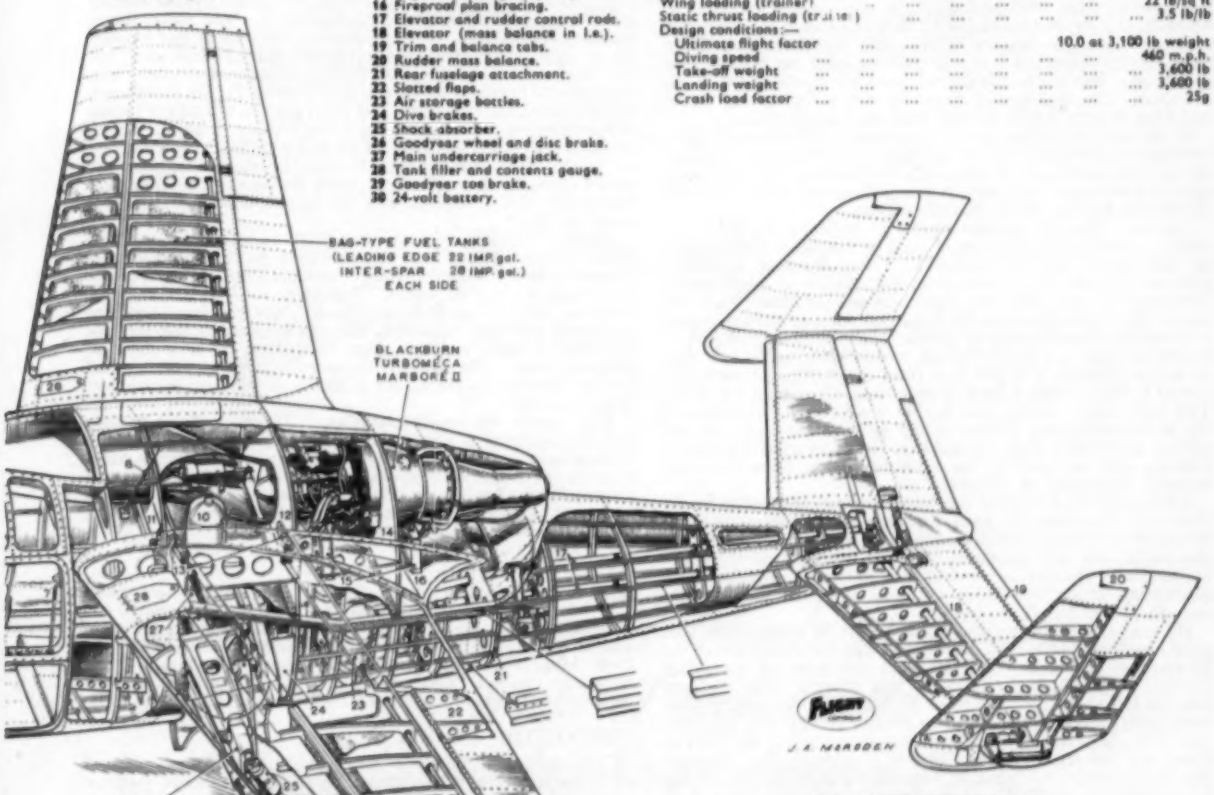
Blackburn-built Turboméca Marborés, it is stated, could be made available to meet this programme, and a higher rate of production is possible with advance notice.

KEY TO DRAWING

1 Pressure head.
2 Pneumatic nosewheel jack.
3 Central control pedestal.
4 Single-curvature Perspex windscreen.
5 Instructor's seat (25 g).
6 Pupil's seat (25 g).
7 Rear cabin space.
8 V.H.F. aerial.
9 Pneumatic flap jack.
10 Fuel recuperator.
11 Main spar frame.
12 Front fireproof bulkhead.
13 Wing/fuselage attachments.
14 Intermediate firewall.
15 Engine mountings (3-point).
16 Fireproof plan bracing.
17 Elevator and rudder control rods.
18 Elevator (mass balance in l.e.).
19 Trim and balance tabs.
20 Rudder mass balance.
21 Rear fuselage attachment.
22 Slotted flaps.
23 Air storage bottles.
24 Dive brakes.
25 Shock absorber.
26 Goodyear wheel and disc brake.
27 Main undercarriage jack.
28 Tank filler and contents gauge.
29 Goodyear toe brake.
30 24-volt battery.

LEADING DATA

Tare weight	1,800 lb
Operational weight (trainer)	3,100 lb
" " (communications)	3,600 lb
Span	28ft 0in
Length	27ft 0in
Height	6ft 3in
Wing area	140 sq ft
Wing loading (trainer)	22 lb/sq ft
Static thrust loading (trainer)	3.5 lb/lb
Design conditions:—	
Ultimate flight factor	10.0 at 3,100 lb weight
Diving speed	460 m.p.h.
Take-off weight	3,600 lb
Landing weight	3,600 lb
Crash load factor	25g



This cut-away drawing by a "Flight" artist shows the Student and its equipment as it will be when completed—which should be not later than the middle of next year.

ESTIMATED PERFORMANCE

With Marboré engine.—Take-off weight, 3,100 lb; fuel load at take-off, 800 lb; service load, 500 lb; take-off distance over 50ft (still air), 550 yd; landing distance over 50ft (still air), 550 yd; initial rate of climb, 2,440ft/min; time to 10,000ft, 4.7 min; time to 20,000ft, 11.3 min; max. speed (s.l.), 295 m.p.h.; cruising speed (s.l.) 254 m.p.h.; at 10,000ft, 262 m.p.h.; at 20,000ft, 268 m.p.h.; still-air range at 10,000ft and 150 m.p.h. (no allowances), 463 st. miles; max. duration at cruising threshold speed, 3.1 hr; typical training range, 424 st. miles; typical training endurance, 2.06 hr. Typical training flight assumes take-off and climb to 20,000ft; 15 min at maximum cont. cruise at 20,000ft; 78 min at economical cruise at 20,000ft; descent at idling power; 10 per cent reserve after landing.

With Palas 600 engines.—Take-off weight, 3,100 lb; fuel load at take-off, 750 lb; service load, 500 lb; take-off distance over 50ft (still air), 625 yd; landing distance over 50ft (still air), 550 yd; initial rate of climb, 2,050ft/min; time to 10,000ft, 6.2 min; time to 20,000ft, 16.8 min; max. speed (s.l.), 284 m.p.h.; cruising speed (s.l.), 242 m.p.h.; at 10,000ft, 248 m.p.h.; at 20,000ft, 249 m.p.h.; still air range at 10,000ft and 150 m.p.h. (no allowances), 400 st. miles; max. duration at cruising threshold speed, 2.7 hr; typical training range, 315 st. miles; typical training endurance, 1.55 hr.

Models of the aircraft used on the 21-year-old Kangaroo route are inspected by leading personalities present at the dinner reported below: (l. to r.) Sir Thomas White, High Commissioner for Australia; Sir Miles Thomas, chairman of B.O.A.C.; H.R.H. The Duke of Gloucester; Capt. L. V. Messenger (B.O.A.C.), who was first officer on the first service to Australia; and Sir Hudson Fysh, chairman of Qantas.

CIVIL AVIATION

KANGAROO ROUTE ANNIVERSARY DINNER

A GREAT company gathered at the Dorchester Hotel, London, on December 8th for a dinner celebrating the 21st anniversary of the Kangaroo route partnership service between the United Kingdom and Australia. [This anniversary was the subject of an article in *Flight* for December 2nd.] The toast of "The B.O.A.C./Qantas Partnership" was proposed by H.R.H. The Duke of Gloucester, and replies were made by Sir Miles Thomas and Sir Hudson Fysh, chairmen of the two airlines.

The Duke of Gloucester recalled that on December 10th, 1934, two days after the departure from Croydon of the first regular Australia-bound airmail from England, he had dispatched the first westbound service from Brisbane. In the long history of the British Empire there could have been few events of greater significance than the beginning of the regular service to Australia and its later expansion to New Zealand. During his two years as Governor-General of Australia the Duke had flown about 64,000 miles and was thus able to judge for himself how greatly that country had benefited from the development of air transport. The feeling that Australia was an integrated whole had been lacking during his first visit ten years previously.

In his reply Sir Miles gave an interesting piece of news. After referring to the Comet 3's recent flight from Hatfield to Sydney, he said that as a result of talks with Sir Hudson Fysh that week, Qantas would now consider operating Comet 4s when B.O.A.C. introduced the type on the Kangaroo route.

The first Imperial Airways service to Australia, Sir Miles recalled, carried only half a ton of mail and cargo, no passengers, for destinations beyond Singapore. Today the average weekly load leaving the United Kingdom on services to Malaya and Australia was more than 300 passengers and 34 tons of mail and cargo. During the 21 years the Kangaroo route journey time had been reduced from 12 days to 73 hours; next year, when B.O.A.C. hoped to introduce the Britannia, it was likely to be less than 48 hours. During the past five years the Kangaroo route had earned B.O.A.C. alone a profit of more than £5½m, said Sir Miles. This had been a major contribution towards the attainment of the wider underlying motive in the mandate given to the two airlines in the early days—to make air transport a self-supporting industry and an asset to the Commonwealth, "free from the artificial respiration of subsidies."

Sir Hudson Fysh recalled the "prophetic words" spoken by the Duke of Gloucester 21 years earlier when he dispatched the first Qantas service from Archerfield Aerodrome, Brisbane. "Of the importance and significance of this inauguration there can be no doubt. Each new method that makes for speedier communication within the Empire must be of benefit to its people who are spread across the world."

He paid tribute to those pioneer spirits in England in both government and airline circles who had laid the foundation of the Empire air link and who "had held the hand of the infant Qantas." Indeed both Imperial and Qantas were infants; but, Sir Hudson said, "they lived in a bigger house than we did, and, figuratively speaking, went to a better school. But we learnt fast with their support and encouragement; and I do wish to thank my old friend George Woods Humphery, his chairman Sir Eric Geddes, Sir George Beharrell, Dennis Handover and other members of W.H.'s team, who worked under such great stress to lay the original foundations."

IDRIS ACCIDENT FINDINGS

AN error of judgment on the part of the captain is stated by the official investigation board to have caused the accident to B.O.A.C. Argonaut G-ALHL at Idris Airport, Tripoli, on the night of September 21st. The aircraft caught fire after striking trees 1,200 yd short of runway 11 at Idris while making its fourth approach to land in conditions of strong wind and poor visibility. Of the 40 passengers, 13 were killed, 16 injured and 11 uninjured; two of the crew of seven—a steward and the stewardess—were killed and the remainder were injured.

The accident was investigated by a three-man board set up by the Libyan Minister of Communications, and consisting of Mr. R. A. Webb, Director of Civil Aviation (president); Mr. R. P. Garnons Williams, senior inspector of accidents, M.T.C.A.; and Mr. B. J. Folliard, deputy inspector of accidents, B.O.A.C. Their report was issued by the Ministry of Transport and Civil Aviation on December 12th.

The commander of the aircraft, Capt. R. D. E. Griffiths, an Australian, joined B.O.A.C. as a first officer in 1946 and became an Argonaut captain in March 1954; his flying hours totalled 9,417. The first officer, J. I. Davies, had flown 6,959 hours.

Visibility at the time of the accident was estimated as at least 1,600 yd, compared with B.O.A.C.'s minimum of 1,000 yd for night landings at Idris. There was no low cloud, and the captain was making a visual approach to runway 11. The report found that the decision to use this runway rather than the longer runway, 18, in order to minimize cross-wind effects, was justifiable, but that the captain should have revised this decision after three unsuccessful attempts to line-up and land on 11. It considered, but dismissed, the possibility that the captain confused the setting of his altimeter, which showed a QNH reading giving the height of the aircraft above sea level, rather than a QFE setting indicating its height above the airfield. During the third overshoot, the report notes, the first officer reminded the captain that they were flying with QNH settings, and the captain replied that he was aware of this.

During the fourth, final approach to the runway, the first officer called "runway ahead"; the captain noted that his altimeter was indicating 610ft (about 350ft above runway level), reduced power and began a visual approach. Turbulent conditions, the report observes, made accurate flying difficult. Within a few seconds of beginning his visual approach, the captain partially lost sight of the runway lights and saw what he thought to be a cloud of billowing sand. He reverted to instrument flying and reached for the throttles to climb, but at the same moment the aircraft struck the trees.

The captain, the report concludes, "allowed his desire to keep the runway lights in view to affect his judgment, in that during a visual approach to the runway he failed to make adequate reference to his flight instruments. In the restricted visibility the runway lights gave him insufficient guidance as to attitude, height and angle of approach and unknowingly he permitted the aircraft to descend below its correct approach path."

DC-8s FOR E.A.L.

AN order for 18 Douglas DC-8s, with an option on eight more, has been placed by Eastern Air Lines. With spares, the contract is worth $165m (£59m), and it brings the number of DC-8s ordered to 95. Six of Eastern's DC-8s are due for delivery from May 1959; these aircraft will have J57 turbojets. The remainder, with a "much larger" P. and W. turbojet, will be delivered between the spring of 1960 and the autumn of 1961.

FRIENDSHIP STRETCHED

THE second prototype of the Fokker F.27 Friendship and subsequent production aircraft will have a stretched fuselage embodying a 3ft extra section between the cockpit and the leading edge of the wing. This modification, which brings the total fuselage length to 76ft, is expected to have "little or no influence on performance figures." It will enable the aircraft, in standard form, to carry 32 passengers without reduction of existing cargo capacity (282 cu ft).

MARCONI RADAR FOR JOHANNESBURG

INSTALLATION of Marconi Type S.232 radar at Jan Smuts airport, Johannesburg, is expected to be completed by the summer of 1956. The work of installation and training of airport personnel will be undertaken by Marconi (South Africa), Ltd. The contract is valued at some £40,000. Described as multi-purpose radar, the Type S.232 is also being manufactured for London Airport; it can be used both for long-range surveillance and for control of aircraft within the airport terminal area, and is said to meet all radar requirements other than precision approach. The equipment has a range of ¼ mile to over

Wishing all our good friends everywhere
the finest of high spirits
and happy landings during 1956

ESSO

ESSO PETROLEUM COMPANY LIMITED, 36 QUEEN ANNE'S GATE, LONDON, S.W.1 AVIATION TECHNICAL SERVICE, BELIANCE 1261

MORE

Redifon

FLIGHT SIMULATORS

ARE IN USE IN EUROPE AND CANADA

THAN ANY OTHER MAKE

★

THIS MODERN AID TO AIRCREW

TRAINING PROFICIENCY

IS MAKING A POSITIVE CONTRIBUTION

TO SAFETY

Flight Simulator Division

REDIFON LIMITED · CRAWLEY · SUSSEX

A Manufacturing Company in the Rediffusion Group

CIVIL AVIATION . . .

100 miles and up to 8 P.P.I. displays can be used with one aerial head. At Jan Smuts the radar head will be remotely operated from the control tower at a distance of about 1½ miles.

GATWICK DEVELOPMENTS

THE first two contracts for the development of Gatwick Airport were let on December 2nd, announces the M.T.C.A. One, for the construction of diversion roads, was awarded to Tarmac, Ltd.; the other, for the demolition of 17 houses and ground clearance preliminary to construction of the runway, was awarded to the Crawley Demolition Company.

The road contracts will cover the diversion of two and three-quarter miles of the London-Brighton trunk road (A.23), the construction of a link road from A.23 to the Reigate Road (A.217), and the diversion of 900 yd of the Lowfield Heath-Charlwood Road. Work under both contracts will be started before the end of the year.

MORE SUPER-Gs ORDERED

EIGHT L.1049G Super Constellations have been ordered by T.W.A., with delivery beginning in June 1956. The airline's present fleet of 125 Constellation-series aircraft (largest one-type fleet in the world) includes 20 L.1049Gs. These aircraft, dubbed Super-Gs by T.W.A., were recently introduced on North Atlantic services.

T.C.A. SELL FREIGHTERS

THREE Bristol Freighters and a DC-3 cargo aircraft have been sold by Trans-Canada Air Lines to Central Northern Airways, of Winnipeg. The total price is given by T.C.A. as £394,642. Announcing the sale, the company said that it "has now completed the conversion of an adequate number of North Stars to all-freight carriers. These have a greater capacity and are faster than the Bristols which are now being sold."

MR. A. A. PRIESTER

WE record with regret the death of Mr. Andre A. Priester, chairman of the I.A.T.A. technical committee and one of its founders in 1945. He died suddenly in Paris on November 28th after the opening session of the committee's tenth anniversary meeting. In the words of I.A.T.A.: "His outstanding services . . . will remain as a lasting memorial in the eyes of the airline industry." Mr. Priester, who was 64, was a vice-president of Pan American World Airways, which he joined in 1927. He was responsible in the early years of PanAm for the technical direction of the company's operations and for the selection of new equipment; he played a leading part in the development of many famous airliners including the Fokker F.7 and F.10, the Ford Trimotor, Sikorsky S-38 and Boeing Stratocruiser. Recently he had been concerned with jet transport development. He learnt to fly after the first world war, in which he served as lieutenant in the Royal Netherlands Army. His aviation career began with K.L.M. in 1920.

BREVITIES

A PARTY of six senior officials of Lufthansa recently spent a week studying the Viscount at the Weybridge and Hurn factories of Vickers-Armstrongs, Ltd. Among the party were Herr Reishenbaker (head of planning) and Herr Sussenguth (deputy chief engineer).

* * *

B.K.S. Air Transport, Ltd., are reported to be planning the expenditure of more than £1m on replacements for their fleet of DC-3s and Vikings. The choice of type has been narrowed down to two—the Handley Page Herald and the Fokker Friendship, which was recently inspected at Schiphol by Mr. T. D. Keegan, one of the directors of B.K.S.

* * *

The appointment of Mr. Derek J. Platt as commercial manager is announced by Hunting-Clan Air Transport, Ltd. For the past year Mr. Platt has held a similar appointment with British West Indian Airways and was previously commercial manager, Cyprus Airways, for six years. He joined Imperial Airways as a trainee in 1936 and subsequently served with both B.O.A.C. and B.E.A.

* * *

Two overseas airlines have announced the adoption of the Kelvin Hughes periscopic sextant for British-built aircraft now on order. Central African Airways have specified it for their five Viscount 748s, and the instrument will also be fitted in the three long-range Britannia 300s ordered by El Al.

* * *

A contract worth "several million dollars" has been awarded to the Solar Aircraft Co. by Lockheed Aircraft Corporation for construction of stainless steel engine-nacelle components on the new L.1649 Super Constellation.

* * *

Capt. Rudolf Mayr, chief pilot of Lufthansa, is one of the four captains who, as reported recently, are the first German pilots to take command of German-registered civil aircraft since the war; the others are Walter Blume, Jupp Foerster and Fritz Stehle. Mayr and Blume are veterans of the pre-war Lufthansa, having between them made a total of 166 crossings of the North and South Atlantic. Foerster and Stehle both began flying with the Luftwaffe and took out civil licences in the Middle East in 1948. All four are captaining DC-3s on German internal routes.

* * *

S.A.S. have created the new post of general sales manager for Great Britain and Eire as part of an expansion of their sales activities. It will be filled by Lt. Col. Colin Gray, who was until recently managing director of Davell and Co. (London), Ltd.

* * *

Air transport movements at U.K. airfields in September 1955 totalled 31,000, and traffic for the month comprised 63,333 passengers, 16,000 tons of freight and 1,430 tons of mail; these figures represent percentage increases of respectively 16, 22, 42 and 18 over the total for September 1954.

* * *

Aircraft crossing the eastern half of Cyprus have been forbidden to fly below 9,000ft and a limitation of 7,000ft applies to the rest of the island. These regulations are reported to be designed to prevent illegal smuggling of arms and explosives or the entry of unwanted persons.

* * *

The A.R.B. have approved an increase from 1,250 to 1,500hr in the overhaul life of the de Havilland airscrews fitted to Elizabethans of B.E.A. The overhaul life of these four-blade, 16ft units was originally set at 400 hr and has increased steadily since the Elizabethans went into service in March 1952.

* * *

Hunting-Clan Air Transport are the latest independent airline to use the Airwork air terminal in Brompton Road for handling of their passenger services. Opened in December 1953, the terminal is also served by Britannia, Dan-Air, Eagle and Skyways, and, of course, by Airwork.

* * *

Operational user trials of Decca A.S.M.I. (airfield surface movement indicator) radar began at London Airport on November 30th. During the trial period information from the radar screen will be used by air traffic control to supplement, but not to replace, current taxying procedures.

Personalities at the British Airline Pilots' Association party on December 7th: (Left) A. Cdre. A. S. Ellerton, representing the R.A.F.A., is seen with three B.O.A.C. captains—A. G. Store (Stratocruisers), H. L. N. Glover and D. A. Briggs (both Argonauts); (centre) the seated figures, obviously talking shop, are B.E.A. Viscount pilots—1st/Off. B. J. Beech and Capt. P. E. Bressey; (right) Mr. J. D. Profumo, Parliamentary Secretary, M.T.C.A. (right), with Capt. S. J. L. Key (Elizabethans). "Flight" photographs

ROLLS-ROYCE AVON (continued from page 906)

is one pipe for each of the upper groups of triple valves and further pipes for the individual bleed valves on the lower part of the compressor casing.

A serious interest in reheat was first taken by Rolls-Royce in 1946. This method of obtaining extra thrust from the unburnt air passing through a turbojet was, of course, well known, but emphasis at Rolls-Royce was placed primarily on developing the basic engine.

Reheat testing began using Derwent engines in a special installation on a Meteor. It soon became apparent that flight testing was the most important part of the development, although some major control, mechanical and combustion problems could be dealt with to some extent on the test bench. Although a larger-diameter jet pipe was used, the gas velocity of 600 ft/sec over the burner raised very difficult flame stabilization problems in spite of the high inlet temperatures of 600 to 700° C. Having started a healthy fire, the little matter of confining it to the core of the jet pipe and avoiding burning out the walls was also—and still is—a major problem. Control of the fuel supply meant the development of an entirely new and separate system from the engine, and an air-driven turbo pump driven by compressor delivery air was developed to meet the case. Some 500 hours were accumulated on three Meteors before the weight of development was transferred to the Avon. Whereas there had been no intention of using reheat on production Derwents, several proposals were made to use the system with the Avon in more advanced fighter aircraft than the Meteor.

Much of the past testing "read across" to the Avon, but changes in detail shape, air pattern and pressure level involved much more testing on the bench and in flight. A considerable amount of small-scale combustion rig work was going on in parallel during this period with a view to investigating some of the fundamental aspects of the problem and evolving a true scale-model technique to speed up the main development problem and to open up additional testing facilities. A Canberra was modified to take two reheat installations and this proved to be a very fine flying test-bed. The normal Avon engines were used and the rear end of the nacelle was opened out and suitably strengthened to take the larger-diameter reheat jet pipe. Having the advantages of an observer, ample room for instrumentation, adequate fuel tankage and extreme altitude, it fulfilled almost every requirement.

The conversion of the Canberra and the Meteors from the design to the practical work involved was undertaken by the Rolls-Royce Hucknall Flight Establishment, as also was the flight-test programme. Many hundreds of hours flying were accumulated during development of the Avon system. In spite of the successful testing on the Derwent up to 43,000ft, the Avon encountered completely new combustion troubles and lighting difficulties at altitudes below the Derwent and a great deal of work was necessary before a satisfactory performance was obtained. The problems were even then not completely solved since the identical reheat pipe and burner when used in different types of fighter installations showed up some more minor troubles which had to be solved by individual modifications relating to each aircraft.

For the purpose of description the reheat jet pipe can be conveniently divided into three sections: the diffusing section, having a burner at its outlet; a parallel, or burning, section; and a variable-area nozzle. The pipe has two concentric stainless steel skins, the inner or hot skin carrying the gas-pressure loads and being, in turn, supported by the cool outer casing. It is this casing that carries the structural loads, although axial thrust loads (rearwards non-heat and forwards on reheat) are taken on the engine exhaust unit by a flexible coupling.

An ejector on the final nozzle sucks air between the two skins, both during and without reheat. This, whilst hardly cooling the inner skin, supplies an effective insulating blanket for the outer skin. Since the aircraft nacelle construction is usually of light alloy, the reduction in temperature of the outer skin is an important point. In addition, thermal blankets are used in certain installations.

The variable nozzle is of the relatively simple two-position clamshell type and pays a small penalty in the non-reheat thrust due to side pillage of the gas stream. The reheat burner consists basically of an annular vee gutter concentric with a central cone and interconnected with it by short radial gutters of the same section. Since the wider the gutter, or cone, the greater the stability, the central cone has a greater stability than the gutter, even though its blockage area is small, and some of its margin of stability can be used to provide some piloting of the outer gutter. The blockage of the burner results in a small pressure, and hence thrust loss, both during non-reheat and reheat conditions, although it is, of course, completely masked in the latter condition by the reheat boost.

In the fuel system high-pressure air is tapped off the compressor to drive the turbo fuel pump. This consists of a small two-stage turbine mounted on the same shaft as a centrifugal pump and, relative to other types of pump, it has a very high flow and pressure output for a low weight. When reheat is selected a valve admits air to the turbo pump which then commences to build up fuel pressure against a closed fuel valve. When the pressure has reached a set value, a switch opens the fuel valve and reheat variable nozzle simultaneously. Ignition of reheat is by a high tension spark plug positioned in the relatively low velocity of the central cone and fed by a piloting fuel supply. Once combustion has begun in the cone, the flame propagates radially outwards along the interconnectors and lights the main gutter.

Control of the reheat fuel is by an air throttle in the line to the turbo pump. The basis of control is the fact that a normal non-reheat engine maintains a fixed pressure ratio across the turbine regardless of altitude and small variations of engine speed from the maximum conditions. This pressure ratio is used in the reheat case by means of a diaphragm and servo-control unit to alter the opening of the air throttle according to the deviation from the normal pressure ratio. This is a true "sensing" system and with a control of this type the pilot sees no difference in any of his engine flight instruments. When reheat is cancelled the nozzle and fuel valve are closed together and the engine remains at the same rotational speed. Partial reheat thrust is obtained by reducing r.p.m., and hence reducing the engine and reheat thrust together.

All the Avons so far described are direct developments of the original AJ.65, and are thus, to some extent, constrained to the theoretical approach of ten years ago. Nevertheless, various studies led Rolls-Royce to the RA.14, which represents a noteworthy advance, and can in no sense be considered as a mere "improvement" of the first Avon generation. Although really a completely new engine it was given the appellation of Avon, and appears to have founded a second generation of more advanced engines.

Considerations of security prevent a description of any of these later Avons, but certain deductions may be made with assurance from a superficial examination of them. For example, there are clearly more than the original 12 stages of compression; and this presupposes a higher pressure ratio, particularly taken in conjunction with the increased work-per-stage which can now be obtained. The annulus area at the intake is greater than on the early Avons, indicating a greater mass flow. A detail point is that the compressor bleed valves are of the sliding type, as distinct from the lift type originally fitted.

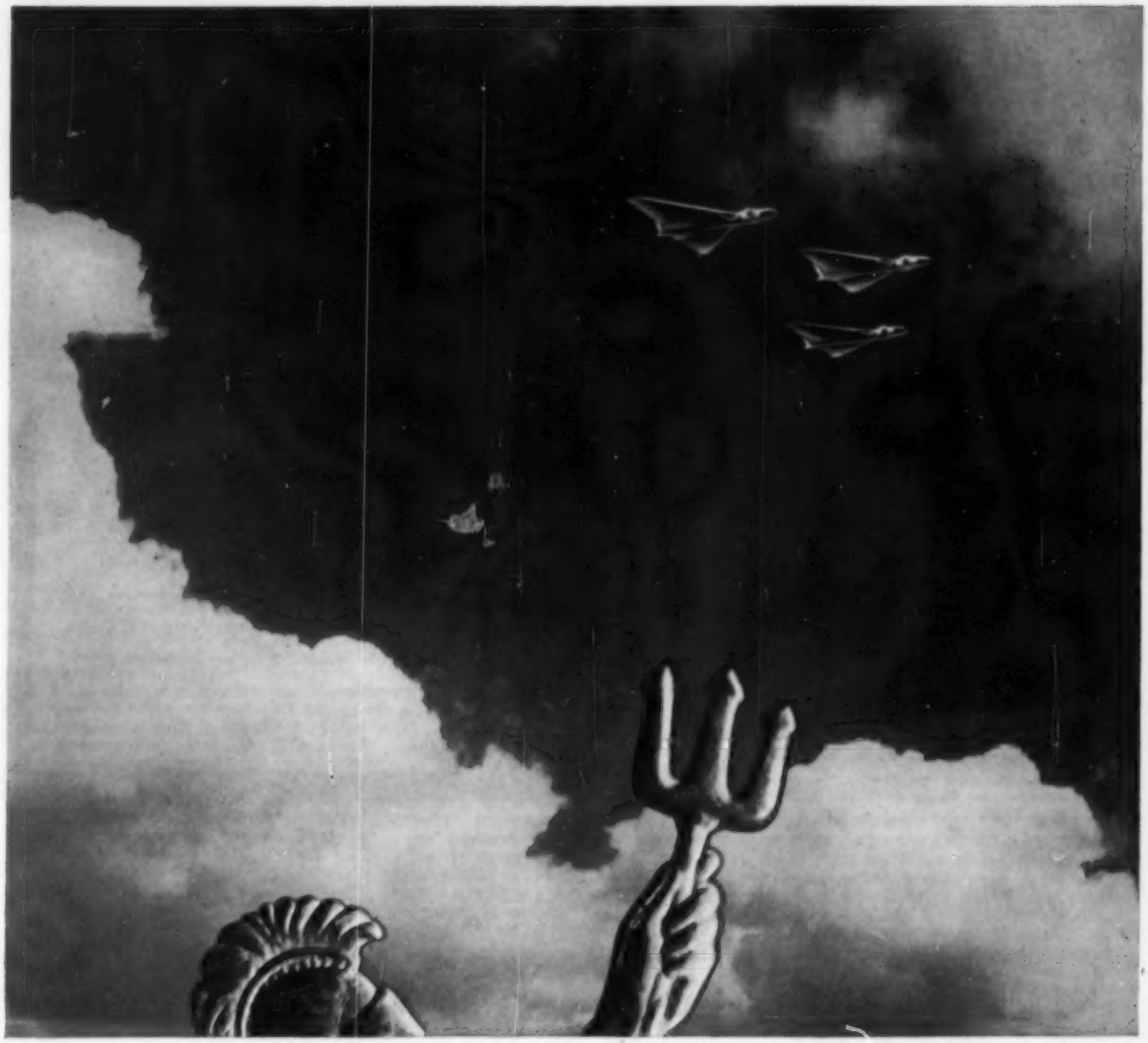
Of the superficially evident alterations introduced by the new family of Avons, the most obvious is the redesigned combustion system. This is clearly of the annular, or cannular, variety, although there seem to be eight fuel burners as before. Adoption of such a system has clearly enabled Rolls-Royce to develop a very advanced design capable not only of passing a considerably greater mass flow than that of the earlier engines, but of actually reducing the overall diameter of the engine. On previous Avons the fuel pump—a Lucas dual unit—is mounted on the right-hand side of the external wheelcase; in the new Avons the pump is attached to, and driven from, a unit combining the external wheelcase and oil sump. Another visible change is the elimination of flexible piping in favour of stainless-steel tubing, and most of the new engines carry a fuel control-unit group on the lower left-hand side, whereas these auxiliaries were separately located on the RA.7.

The experience of Rolls-Royce, coupled with much increased knowledge at the outset, has enabled development of the second generation to proceed much more rapidly than did that of the first. For example, the RA.14 prototype was first run on November 17th, 1951—the same year as that in which design started. On February 28th, 1953, RA.14s were airborne for the first time, and production deliveries were being made the following July.

Of the various branches of the second generation—such as the RA.24 and RA.28—no details may at present be published. It has been stated that commercial powerplants of this general type are being developed, and these may be expected to provide exceptionally competitive fuel consumption and overhaul life. The latest of these transport Avons is the RA.29, which has a rated thrust of 10,500 lb at 8,150 r.p.m., and is specified for the de Havilland Comet 4.

In view of the very high thrusts being achieved by late versions of Avon, it is reasonable to assume that engine operating temperatures are now considerably greater than they were when the first Avons were planned. Rolls-Royce recently stated that their Tyne turboprop incorporates "design improvements which allow high flame temperature for take-off and cruising without impairing the overhaul life of the engine. These developments have been derived from the latest military jet engines . . ." As it has been announced that the Tyne incorporates air-cooled turbine blading it is not unreasonable to infer that such blading is also fitted in the latest types of Avon.

Be that as it may, it is rarely that one can record such a story as has already been written by the Rolls-Royce Avon. In this account we have given only the first half of the story; the rest will follow in the years to come.



F-R THREE-PRONG ORGANISATION

serves the aircraft industry

PROBE & DROGUE
The flight refuelling system adopted by the R.A.F. for Britain's V Bombers and used as standard in aircraft of the U.S. Navy

FUEL SYSTEM EQUIPMENT
The most complete range of pressure refuelling components in the world. Used by leading constructors everywhere

AIRCRAFT SERVICES
Overhaul, repair and modification. Aircraft hangarage and servicing. Construction of airframe components

FLIGHT REFUELLING LIMITED

TARRANT RUSHTON AIRFIELD, BLANDFORD, DORSET, ENGLAND TELEPHONE: BLANDFORD 501 TELEGRAMS: REFUELLING, BLANDFORD

WESTON

AIRCRAFT INSTRUMENTS

for the indication of

ELECTRICAL POWER · TEMPERATURES ·
PRESSURES · TURBINE SPEEDS ·
CONTROL SURFACE MOVEMENTS ·

also

NAVIGATIONAL AIDS ·
GROUND TEST SETS ·

SANGAMO WESTON LIMITED
ENFIELD, MIDDLESEX, ENGLAND.
Tel: Enfield 3434 Grams: Sanwest, Enfield.
Scottish Factory: Port Glasgow, Renfrewshire.
Branches: London, Glasgow, Manchester, Newcastle-on-Tyne, Leeds, Liverpool, Wolverhampton, Nottingham, Bristol, Southampton, Brighton.

This typical Weston Ratiometer, with 270° scale, and available in large or small S.A.E. case, can be used in conjunction with a resistance bulb, a pressure transmitter, or a position transmitter, to indicate a variety of temperatures, pressures or positions.

on the ROLLS-ROYCE AVON . . . .

Teddington Aircraft Controls Ltd. are suppliers of
Hot Air Valves for Engine De-icing and Aircraft Hot Air Supply;
Differential Pressure Switches for Fuel Filter Ice Warning,
and Reheat Solenoid Valves for the Rolls-Royce 'Avon' engine.

. . . . *aircraft equipment by* TEDDINGTON

TEDDINGTON AIRCRAFT CONTROLS LTD., MERTHYR TYDFIL, SOUTH WALES. Telephone: Merthyr Tydfil 666.
London Office: 51 BROMPTON ROAD, S.W.3 Telephone: KENsington 4808.

The new carrier H.M.S. "Ark Royal" moving out of Grand Harbour, Valetta, bound for Toulon and a goodwill visit.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

R.A.F. Christmas Plans

ONCE more, many R.A.F. stations are holding childrens' Christmas parties, and the ubiquitous Father Christmas will use various unorthodox means for attending these functions. Amongst his conveyances will be jet aircraft, helicopters, bomb trolleys made up to look like sleighs, fire tenders and, in one instance, an ejector seat. Both R.A.F. and other children are to be entertained with such treats as pantomimes, plays, films, puppets, conjurors and magicians. Many units are including orphan, sick and spastic children in their plans. Old people will also be catered for.

At R.A.F. Hartlebury, Kidderminster, 1,040 children will be entertained at eight parties between December 18th and January 7th, and 85 youngsters taken to a pantomime in Dudley. The seven children of the staff of a signals unit near Coldingham, Berwick, will have a party at which Father Christmas will arrive by sleigh. Three hundred and ten children of civilian employees and 190 parents will be taken from No. 4 M.U., West Ruislip, to Olympia on January 21st and afterwards will be given high tea and gifts. Tomorrow will be the big day for children at No. 19 M.U. St. Athan, and the O.C., W/C. W. R. Wills-Sandford, will be Father Christmas, arriving in an Oxford. No. 32 M.U. at the same base will also hold a party, as will No. 16 M.U. at Stafford. Hullavington and Driffield will entertain crippled children and orphans in the neighbourhood and the small mess of R.A.F. Longbenton, near Newcastle, will entertain six orphans.

At Binbrook, Father Christmas will arrive by sleigh and descend *via* the chimney. At Honiley, W/C. Barthropp will, as Father Christmas, arrive by Vampire and re-embark in a sleigh drawn by children to attend their party tomorrow, in contrast to Thornaby and Middleton St. George, where arrival will be by helicopter. At Sutton-on-Hull the School of Fire Fighting will appropriately convey Father Christmas in a fire tender, while at Colerne he is appearing through curtains in an ejector seat. Bringing cheer for the sick will be a number of choirs and groups of carol singers who will tour the wards of three R.A.F. hospitals at Ely, Wroughton, and Cosford. From Watnall officers will call on old-age pensioners in the village with gifts, and Linton-on-Ouse expects to be able to give a donation of over £50 (raised by a record request programme on the station's internal broadcasting system) to Fairfield Sanatorium for Tuberculosis, York.

R.A.F. on Active Service

A PROCLAMATION by Field Marshal Sir John Harding, the Governor of Cyprus, places R.A.F. units in the island on active service for three months. On November 26th, Sir John Harding had declared a state of emergency and two days later the 10,000 troops on the island had been placed on active service.

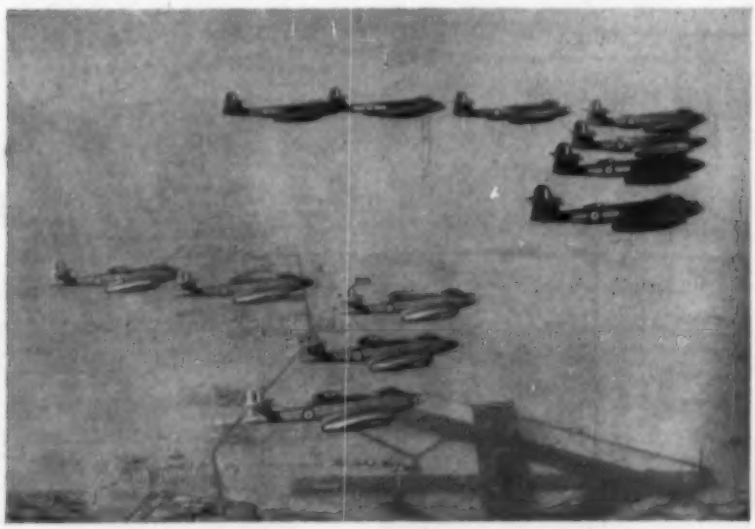
The first batch of wounded, evacuated from Cyprus by Hastings of the casualty evacuation service and brought to England last week, included two R.A.F. men.

The Pathfinder Ball

THE annual Pathfinder Ball, an R.A.F. reunion that is surely unsurpassed for its popularity, took place at the Dorchester Hotel on December 3rd. Among the 600 present were Sir James and Lady Barnes, A.V-M. D. C. T. Bennett (founder/commander the Pathfinder Force), Mrs. Bennett, and Air Chief Marshal Sir Frederick Bowhill and Lady Bowhill. Between dinner and dancing, in accordance with tradition, the choristers of St. Paul's and St. Mark's sang three Christmas carols and later there followed, by contrast, a lively and spectacular floor show.

Jet Provost Progress

AT the beginning of November, NATO Air Training Advisory Group sent a team to Hullavington to evaluate the Jet Provosts which are now being used for an experimental pilot-training course.



The Meteor F.R.9s of No. 208 Sqn., whose standard presentation was recorded last week, fly in formation over the Canal Zone. The colour arrangement on the noses is distinctive and not common in present squadrons.

SERVICE AVIATION]. . .

The official report of the team's findings has not yet been published but it is known that the pilots under training have a very high opinion of the aircraft. It may be that the Jet Provost will follow the piston-engined Provost and other British trainers in finding a market in foreign air forces.

New Zealand S.A.S.

AS part of New Zealand's contribution to the Commonwealth Strategic Reserve a Special Air Service squadron was sent to Malaya last month. The squadron is primarily to form part of the Reserve but it will also be engaged on anti-terrorist operations in the Malayan jungle. From its base at Kuala Lumpur, it will be able to operate anywhere in the Federation.

Marathon Runner Honoured

A STREET in the new Mount Pleasant housing estate of St. Helen's, Lancs, has been named McMinnis Avenue in honour of Sgt. Robert McMinnis, the R.A.F. marathon and cross-country runner, who was born in the town. McMinnis is now a physical training instructor at the R.A.F. recruit centre, Padgate, and this year won the Amateur Athletic Association's marathon and the Polytechnic marathon. He represented Britain at the Kosice marathon in Czechoslovakia. He has been a member of the Sutton Harriers since he was 16 and captained the Combined Services team which, in Germany in 1951, won an eight-country running meeting.

New A.O.C. Gibraltar

IN January, A. Cdre. J. D. Miller, who is completing a course at Imperial Defence College, is to become A.O.C. Gibraltar. He joined the R.A.F. in 1931 and flew with No. 43 Sqn. and the Fleet Air Arm. Shortly after the outbreak of war he took command of No. 145 (Fighter) Sqn., then served in various other fighter posts until going to Malta in 1942 as a sector commander. At the end of 1943, he went to Burma as S.A.S.O. No. 224 Group. He took the R.A.F. Staff College course in 1945, commanded R.A.F. Luqa and Pembroke Dock and became Director of Plans at Air Ministry in 1954.

It is further announced that G/C. S. F. Stapleton, who is also completing a course at the Imperial Defence College, is to become commander of the Northern Sector, Fighter Command, with the acting rank of air commodore. He joined the R.A.F. in 1936 and served with Nos. 3 and 87 Sqns. Early in the war he was on the staff of No. 30 Group and later took command of No. 611 Sqn. and led the Hornchurch fighter wing. Between May 1941 and February 1942, he flew 100 sorties in Spitfires and was awarded the D.S.O. and D.F.C. The remainder of the war he spent instructing in and commanding a navigation, bombing and gunnery school in South Africa. Soon after the war he completed a Staff College course, returned to Fighter Command and then commanded R.A.F. Linton-on-Ouse. He held two posts with the R.A.F. in Germany before becoming chief instructor at the R.A.F. Flying College, Manby.

R.A.F. Squash Racquets

THE Squash Racquets Championship for the R.A.F. has been won by A/C. D. B. Hughes who beat the holder, Sgt. A. E. Catherine. The matches were played at the Lansdowne Club recently.

No. 831 Sqn. F.A.A.

AT Ford, No. 831 Sqn. is being reformed and is anxious to obtain stories, experiences and photographs relating to the squadron's wartime history. Any material would be welcomed and returned if desired. Contributions can be sent to R.N.A.S. Ford, Sussex, or telephoned to the Staff Officer at Littlehampton 720, Ext. 327.

No. 40 Sqn. Tie

THE redesigned tie of No. 40 Sqn. is now available on application to the Squadron Adjutant, R.A.F. Wittering, Peterborough, Northants.

Royal Air Force Appointments

THE following continues recent lists of Royal Air Force appointments as announced by the Air Ministry:—

G/C. C. H. B. Bullock to the Ministry of Supply; G/C. R. J. B. Burns, O.B.E., to R.A.F. Wildenrath, Germany, to command; G/C. O. R. Donaldson, C.B.E., D.S.O., D.F.C., to H.Q. M.E.A.F., for air staff duties; G/C. A. G. Dudgeon, C.B.E., D.F.C., to R.A.F. Brüggen, Germany, to command; G/C. W. N. Hibbert to the Air Ministry for duty in the department of the Air Member for Personnel; G/C. C. F. G. Rogers, C.B.E., to A.A.F.C.E., for staff duties; G/C. S. W. R. Hughes, C.B.E., A.F.C., to R.A.F. Jever, Germany, to command; W/C. P. P. Hanks, D.S.O., D.F.C., A.F.C., to Air H.Q., Cyprus, for air staff duties; W/C. W. Carter, D.F.C., to R.A.F. Ternhill, to command (with the acting rank of group captain); W/C. E. G. Palmer to R.A.F. Eastleigh, Kenya, to command (with the acting rank of group captain); W/C. C. H. Press to the Ministry of Supply (with the acting rank of group captain); W/C. A. J. Trumble, O.B.E., to R.A.F. Bridgnorth, to command (with the acting rank of group captain).

W/C. R. I. Alexander, D.F.C., to Air H.Q., Aden, for air staff duties; W/C. A. H. W. Ball, D.S.O., D.F.C., to H.Q., Bomber Command, for air staff duties; W/C. C. W. Bromley, D.F.C., A.F.C., to R.A.F. Watton, for administrative duties; W/C. P. R. Godby to H.Q., No. 19 (Coastal) Group, for air staff duties; W/C. J. F. Grey, D.S.O., D.F.C., to the Air Ministry, for duty in the department of the Air Member for Personnel; W/C. A. H. Humphrey, O.B.E., D.F.C., A.F.C., to the Air Ministry, for duty in the department of the Chief of the Air Staff; W/C. T. B. Jones to the Air Ministry, for duty in the department of the Air Member for Supply and Organization; W/C. A. D. Murray, D.F.C., to the Air Ministry, for duty in the department of the Chief of the Air Staff.

S/L. J. E. Frith to the Air Ministry, for duty in the department of the Chief of the Air Staff (with the acting rank of wing commander); S/O. C. E. Warren, W.R.A.F., to the Air Ministry for duty in the department of the Air Member for Personnel (with the acting rank of wing officer); S/L. W. H. Webber to the Ministry of Supply (with the acting rank of wing commander).

G/C. C. R. J. Hawkins, station Commander of R.A.F. Oakington, No. 5 F.T.S., displaying the badge which was recently approved by the Queen and which he had just accepted on behalf of the unit.

Reunions

THE second A.G.M. and reunion of No. 16 Sqn. Association will be held in London on February 12th next year. Tickets, price 25s, are obtainable from F/L. G. O. Eades, R.A.F. College, Cranwell, Sleaford, Lincs.

The C.F.S. Association's annual reunion dinner will be held in the officers' mess, R.A.F. Little Rissington, on July 6th next year. Particulars will be circulated to members at a later date.

More than thirty R.A.F. police dogs are now being used for guard purposes at R.A.F. installations in Cyprus and more are due in the near future. Here a dog and his handler, Cpl. J. Bolden, are guarding aircraft.

Rotol and British Messier
extend Christmas Greetings
to all their friends
at home and overseas.

AVIATION TRADERS LIMITED

We can assist you in your Aircraft Spare Parts Provisioning programme by offering you the resources available in our Air Registration Board approved Stores at Southend and Stansted Airports, Essex. Our Spare Parts are offered either new and unused or overhauled and released by the extensive Workshops of our Associated Company:

AVIATION TRADERS (Engineering) LIMITED

Listed below are a few selections from our stock:

A. G. S.

A.G.S. Part No.	Description	A.G.S. Part No.	Description
900/1	Coupling l/a	939/9	Stirrup Nut
902/E	Pipe Collars	948/N	Plug l/a
904/B	Sleeve Outer l/a	952/D	Collars
904/C	Sleeve Coupling l/a	953/BB	Coupling nipple
904/F	Union Nut l/a	953/E	Nipple
904/H	Nut Union l/a	953/F	Nipple
904/J	Sleeve Outer	954/G	Sleeve Outer
905/A	Sleeve Inner	956/B	Nipple Adaptors
905/B	Sleeve Inner	956/E	Nipple Adaptors
905/CC	Sleeve Inner	956/F	Nipple Adaptors
905/D	Sleeve Inner	967/17	Screw
905/E	Sleeve Inner	968/12	Screw
905/H	Sleeve Inner	968/14	Screw
906/C	Nipple Adaptor l/a	969/D	Thimble
906/E	Nipple Adaptor l/a	969/G	Thimble
907/F	Union Double Ended	970/B	Washer l/a
908/C	Union Reducing	970/D	Washer l/a
908/E	Union Reducing	970/E	Washer l/a
908/F	Union Reducing	970/F	Washer l/a
908/H	Union Reducing	970/G	Washer l/a
914/C	Shackle	1103/F	Union l/a
916/E	Pin Shackle	1120/10	Cone Tees
934/EM	Ferrule	1135/D	Banjo Bolts
934/JS	Ferrule	1135/E	Banjo Bolts
934/NM	Ferrule		

We shall be pleased to receive enquiries for your Spares requirements and we are prepared to offer Quotations ex stock, of the items we have available

Please send all your enquiries to our Sales Department at:

15 GREAT CUMBERLAND PLACE LONDON, W.1

Telephone: AMBassador 2091 (8 lines) *Cables:* Aviatrade, London
Telegrams: Aviatrade, Wesdo, London

A COMPONENT OF INTRICATE CONSTRUCTION AND PART OF THE FAMOUS ROLLS-ROYCE "AVON" ENGINE AS DESCRIBED IN THIS ISSUE MADE BY

POLARCOLD LIMITED

CONGLETON TEL: 2401-2-3 CHESHIRE

Superior Fabrications and Presswork
Press Capacity up to 1,000 Tons
Hand Fabrications in all materials

ENQUIRIES INVITED

KONTAK

Manufacturing Company Ltd.

are proud to have contributed to the production of the

ROLLS-ROYCE
AVON

BELTON PARK, LONDONTHORPE ROAD
GRANTHAM, LINCS.

CONTRACTORS TO H.M. GOVERNMENT

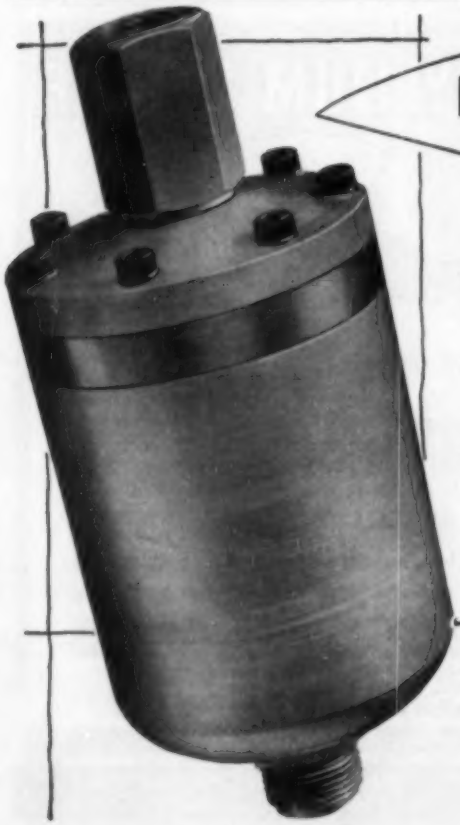
MARICON FLEXIBLE HOSE

A BETTER HOSE OF LIGHTER WEIGHT M.O.S. APPROVED FOR LOW PRESSURE FUELLING SYSTEMS

Maricon Hose is fully approved under M.O.S. Specification D.T.D. (R.D.I.) 3951 and is included in S.D.M. No. 101 (Issue 4) and S.D.M. 183 (Issue 3). Both types A (Non Fire Resistant) and B (Fire Resistant) offer remarkable weight saving advantages as compared with similar hoses and can be supplied in long lengths, or assemblies. Type B has been proved by exhaustive tests to have exceptional fire-resisting qualities. We shall be pleased to supply specification, drawings, and full details on request.

"MARICON" HOSES INCORPORATE "HALLPRENE" SYNTHETIC RUBBERS

MARICON LIMITED, OLDFIELD ROAD, HAMPTON, MIDDLESEX
(MOLESEY 2180)



PRESSURE TRANSMITTER
Catalogue No. 1617

★ Your Oxygen Pressure Gauge test problem solved.

★ Suitable for use with most types of Pressure Gauge Testers.

★ Range up to 4,500 P.S.I.

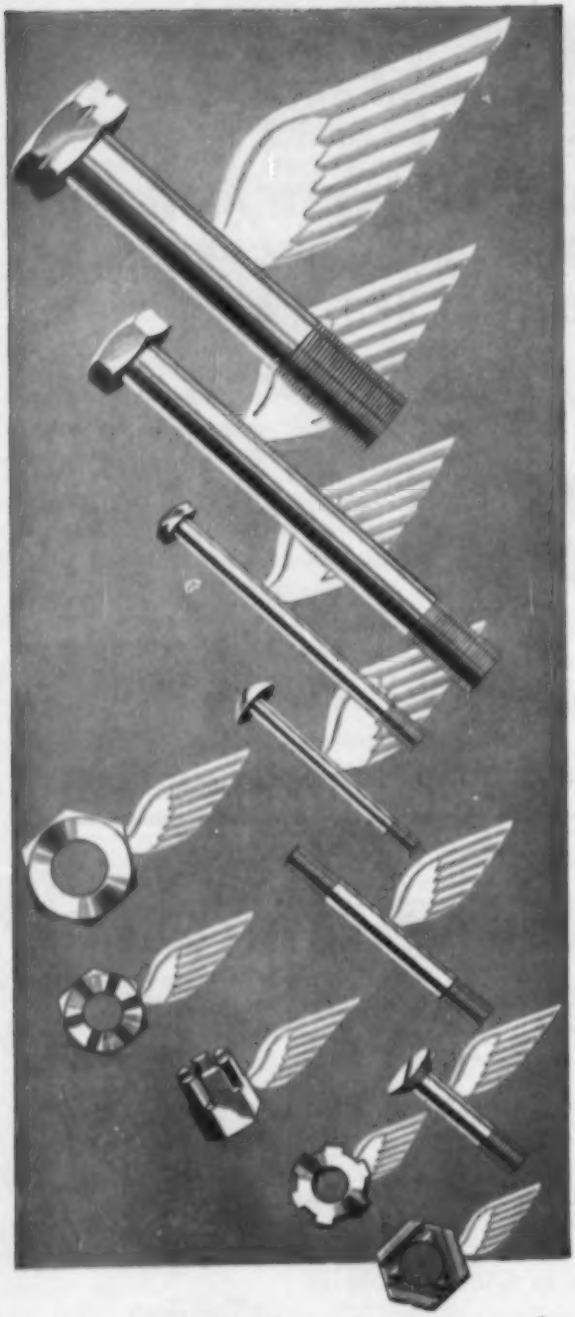
Comprehensive range of test and calibration equipment available for flight and engine instruments, cabin pressure equipment and diluter demand oxygen regulators.

Aeroquipment

BRYANS AEROQUIPMENT LTD.

WILLOW LANE, MITCHAM JUNCTION, SURREY, ENGLAND

Telephone : Mitcham 1607/8/9



Aircraft Bolts & Nuts by

RUBERY OWEN

Produced in all sizes from 6BA diameter as called for in British Standard specifications. Also Special Bolts, Nuts, A.G.S. and repetition Turned Parts to Aircraft Constructors designs and specifications. Fully approved A.I.D. and A.R.B. Write for Stock list.

Head Office and Works: Rubery Owen & Co. Ltd.
P.O. Box 10, Darlaston, Wednesbury, Staffs.
Tel.: James Bridge 3131 (32 lines)

Member of the Owen Organisation

FROM MOTH TO MACH 1

Books on flying, engineering, maintenance, radio and navigational aids can be obtained through your local Smith's shop or bookstall. Lists of titles gladly supplied if required. Any book not in stock at the branch can be quickly obtained from Head Office.

★ *Your stationery and printed matter can also be supplied through our local branch.*

W. H. SMITH & SON

FLYING BOOK SERVICE

Head Office: STRAND HOUSE, LONDON, W.C.2

BERYLLIUM COPPER

CRINKLE washers

Heat treated and plated giving corrosion resistance with high degree of recovery in relation to load, and resistance to "set". Spring locking action suitable for electronic and instrument components. Size range ¼" to 8 B.A.

Prices and samples sent on request.

CONTRACTORS TO THE ADMIRALTY • MINISTRY OF SUPPLY • & OTHER GOVERNMENT DEPTS.

DAVID POWIS & SONS LTD

FORWARD WORKS SPARKBROOK BIRMINGHAM 11 PHONE VIC 1214-8

Osram

LAMPS IN LANDING LIGHTS

★ BRITANNIA

★ AMBASSADOR

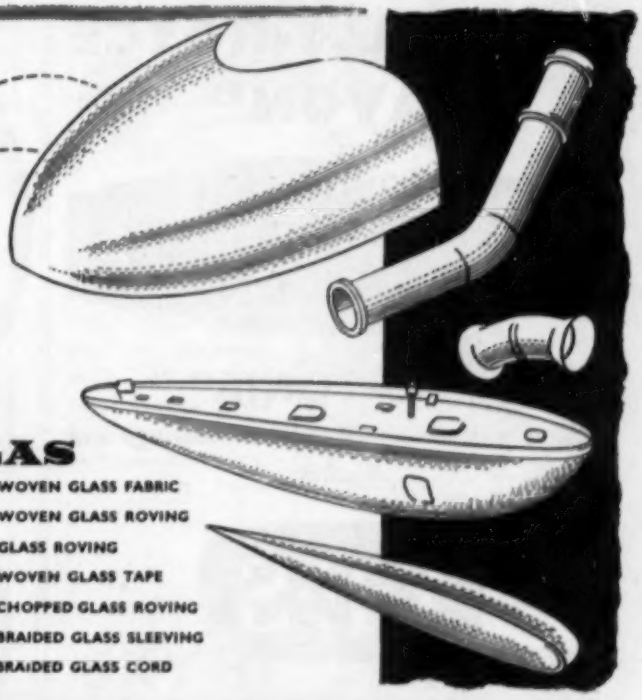
★ VISCOUNT

Osram aircraft landing lamps have been designed for use in Harley landing lights, which are used in so many of the leading makes of aircraft. Osram high efficiency lamps with their accurate filament construction help to provide for safe night landings.

THE GENERAL ELECTRIC COMPANY LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

Think of reinforced plastics

"Duraglas" pure glass products provide structural materials for the reinforcing of plastics. "Duraglas" has a high degree of strength, low weight and ease of fabrication. It is available in many forms, and suitable for a wide variety of structural applications. Full information will be willingly supplied to manufacturers who specify their particular requirements.



Think of DURAGLAS reinforcements

- WOVEN GLASS FABRIC
- WOVEN GLASS ROVING
- GLASS ROVING
- WOVEN GLASS TAPE
- CHOPPED GLASS ROVING
- BRAIDED GLASS SLEEVING
- BRAIDED GLASS CORD

DURAGLAS
REGISTERED TRADE MARK
PURE GLASS PRODUCTS

TURNER BROTHERS ASBESTOS CO. LTD. ROCHDALE ENGLAND
A MEMBER OF THE TURNER & NEWALL ORGANISATION

D6

A magnificent collection of beautifully reproduced aircraft photographs . . .

FLIGHT FLY-PAST

A Portfolio of Aircraft Photographs taken by "Flight" Cameramen

The work of "FLIGHT" cameramen is prized by enthusiasts throughout the world. The attractive portfolio contains an outstanding selection of their recent work, superbly reproduced and includes photographs taken at the S.B.A.C. Air Display, Farnborough, 1955. Includes 24 large plates, printed on high quality art paper.

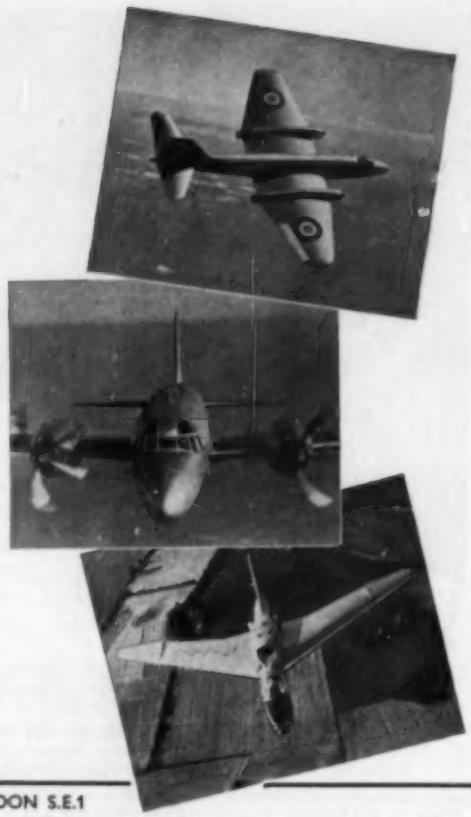
7s. 6d. net. By post 8s. 4d.

Published for "Flight"

Now on sale — get your copy TO-DAY

From booksellers or direct from:—

"FLIGHT" · DORSET HOUSE · STAMFORD STREET · LONDON S.E.1



THE ROLLS-ROYCE "AVON"

is fitted with "EATONIA"
water-cooled Phosphor Bronze Bearings and Bushes

Y·E·S

Sole Producers and Suppliers.
YORKSHIRE ENGINEERING SUPPLIES LIMITED
"EATONIA" BRONZE FOUNDRIES · LEEDS 12
Telephones: 638234-638291 *Telegrams: "Yes Leeds 12"*

ELECTRONIC & RADAR SERVICES

We specialize in the manufacture of

RADIO CONNECTORS (GROUND AND AIRBORNE)

Junction boxes, complete terminations, moulded connectors and inserts, aerial kits, wireless remote control units, insulator and similar assemblies, etc., etc.

Test gear available for testing up to 10,000 volts

As actual manufacturers

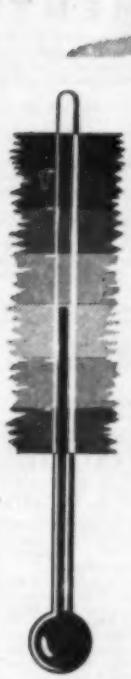
our library records 69,000 different type connectors manufactured over 15 years for the original Ministry of Aircraft Production, M.O.S., Royal Navy, all main Aircraft constructors and various foreign governments

Quick reference can be made to identify and satisfy your exact requirements

A.I.D. A.R.B. I.E.M.E. Fully approved

Enquiries are invited for all the above. Nothing is too large or too small to receive our immediate attention.

E.R.S. Ltd., Brookwood Rd, London, S.W.18
Telephones and Telegrams: PUTney 3402/3



TEMPERATURE MEASUREMENT

"Thermindex" Paints are temperature sensitive compounds which indicate by a sharp, clear cut change of colour when temperature of a surface has attained or exceeded a predetermined value. They are supplied in the form of paints suitable for direct application by brushing or spraying to practically any surface and dry quickly at room temperature. When the temperature of the treated surface is then raised, the original colour of the pigment changes sharply at a definite point and the new colour persists after the surface has cooled down. *Write Dept. AA/2 for full technical details*

"THERMINDEX"
TEMPERATURE INDICATING PAINTS

Sole distributors for Europe and U.K.

Manufactured by Synthetics & Industrial Finishes Ltd.

J. M. STEEL & CO. LTD.
34-36, KINGSWAY, LONDON, W.C.2 Tel: HOL 2832
BRANCHES:
51, South King St., Manchester, 2 Tel: Deansgate 6077/8
45, Newhall St., Birmingham 3 Tel: Central 6342/3

PORTWAY FORGINGS
(WEDNESBURY) LIMITED

A.I.D. APPROVED SUPPLIERS

OF
UPSET FORGINGS
AND
DROP STAMPINGS
TO
ROLLS-ROYCE
FOR
AVON ENGINES

Address:
PORTWAY WORKS, NEW STREET,
WEDNESBURY, STAFFS.
Telephone: Wednesbury 0518-9

SKYHI

HYDRAULIC SERVICE & SALVAGE EQUIPMENT

Note the screwed ram and safety locking collar giving mechanical security.

SKYHI LIMITED are manufacturers of Hydraulic Aircraft jacks in all sizes and capacities from 2 to 75 tons for both manual and power operation. We illustrate a 25 ton model which has a standard hydraulic body and can be supplied with interchangeable legs of varying length to suit different aircraft.

A.6

To overcome the difficulty of moving these large jacks, we manufacture retractable transportation gear as illustrated. With this method jacks can be towed in tandem and accurately positioned under the aircraft lifting pad.

Steerable front wheel with tow-bar

Please write for 16pp. illustrated booklet

SKYHI LIMITED
"SKYHI" WORKS, WORTON ROAD
ISLEWORTH, MIDDLESEX

Telegrams: Skyhijack, Phone, London. *Telephone: HOUnslow 2211*

FLIGHT and AIRCRAFT ENGINEER

PRESS DAY — *Classified advertisement "copy" should reach Head Office by* FIRST POST THURSDAY *for publication in the following week's issue subject to space being available.*

CLASSIFIED ADVERTISEMENTS

Advertisement Rates. 4/- per line, minimum 8/-, average line contains 6-7 words. Special rates for Auctions, Contracts, Patents, Legal and Official Notices, Public Announcements, Public Appointments, Tenders 5/- per line, minimum 10/-. Each paragraph is charged separately, name and address must be counted. All advertisements must be strictly prepaid and should be addressed to FLIGHT Classified Advertisement Dept., Dorset House, Stamford Street, London, S.E.1.

Postal Orders and cheques sent in payment for advertisements should be made payable to Iliffe & Sons, Ltd., and crossed & Co.

Trade Advertisers who use these columns regularly are allowed a discount of 5% for 13, 10% for 26 and 15% for 52 consecutive insertion orders. Full particulars will be sent on application.

Box Numbers. For the convenience of private advertisers, Box Number facilities are available at an additional charge for 2 words plus 1/- extra to defray the cost of registration and postage, which must be added to the advertisement charge. Replies should be addressed to "Box 0000, c/o Flight," Dorset House, Stamford Street, London, S.E.1.

The Publishers retain the right to refuse or withdraw advertisements at their discretion and do not accept liability for delay in publication or for clerical or printer's errors although every care is taken to avoid mistakes.

Situations Vacant. The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is exempted from the provisions of The Notification of Vacancies Order 1952.

Going to the

NATIONAL BOAT SHOW?

see the world's finest barrier creams demonstrated at the

ROZALEX STAND No. 100

ROZALEX LIMITED,
18 NORFOLK STREET, MANCHESTER 2

Pioneers and Specialists in Skin care products

R.408

PRESS NOTICE

DECEMBER 30th ISSUE WILL CLOSE FOR PRESS WITH FIRST POST, MONDAY, DECEMBER 19th.

AIRCRAFT FOR SALE

W. S. SHACKLETON, LIMITED

EUROPE'S LEADING AEROPLANE BROKERS

DE HAVILLAND COMET. The day has not yet come when we can offer one of these majestic and beautiful aeroplanes for sale. We will content ourselves meantime by congratulating de Havillands on the recent flight of the Comet III.

And while we wish them every success with jet airliners we offer for sale some of their less heavenly but equally useful aircraft.

DE HAVILLAND HERON. At the time of writing we can still offer two Mk. 1 Herons, four spare Gipsy Queen 30 Mk. II engines, four spare D.H. constant speed propellers, and a valuable spares holding. Probably the least complicated four engine aircraft in the world, and on short haul routes one of the most profitable to operate.

DE HAVILLAND DOVE. Airframe under 2,000 hours since new, 11 passenger seats, C. of A. until June 1956, STR 9X and Marconi AD97/108/7092. This aircraft is in remarkably good condition, and has a very low tare weight.

DE HAVILLAND RAPIDE. We have just been given the sole agency for the sale of two Rapides which have been operated on an M.T.C.A. contract, and maintained in superb condition regardless of cost. Details will be announced shortly.

DE HAVILLAND CHIPMUNK. Winner of the King's Cup Air Race in 1953, this is one of the very few civilian Chipmunks we have been privileged to offer for sale. Fitted Gipsy Major X engine, two twelve gallon tanks, full dual, blind flying panels in each cockpit, and electrical intercom. A very fine aeroplane.

DE HAVILLAND TIGER MOTH. We are never without a Tiger Moth either ready to fly away or being overhauled. One of those in stock at the moment was entirely stripped and rebuilt by George Hart and "his boys" at the London Aeroplane Club. We could not ask for better workmanship.

Our new illustrated brochure has now gone to press and copies will be available very soon. Please write if you would care to have one—entirely free of charge!

W. S. SHACKLETON, LTD., 175, Piccadilly, London, W.1. Cables: "Shackhud, London." Telephone: HYDe Park 2448-9, 9408. [0070

CARTWRIGHT HAMILTON AVIATION, LTD.

OFFER:

MILES HAWK MAJOR: low engine hours and 12 months C. of A.

MILES MAGISTER: 12 months C. of A.

AUSTER AUTOCRAT: 12 months C. of A.

TIGER MOTH: 12 months C. of A.

MILES GEMINI: 12 months C. of A.

ALSO a large number of commercial aircraft, including amphibians.

INSPECTIONS and demonstrations willingly arranged.

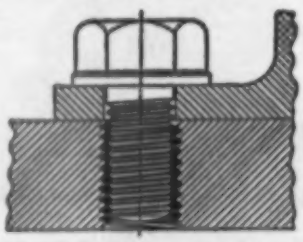
PART-EXCHANGE and hire purchase facilities available.

282, Kensington High Street, London, W.14. Western 0207. Telegrams: Autavia. [0751

MITCHELL AIRCRAFT, LTD.

WE have purchased and sold a number of light aircraft in the last few weeks and our stock has considerably altered since the last publication. For latest details of aircraft actually in stock apply: MITCHELL AIRCRAFT, LTD., Aerodrome, Portsmouth. [0348

WIRE THREAD INSERTS



FOR NEW DESIGNS AND SALVAGE

CROSS MFG. CO. (1938) LTD.
COMBE DOWN, BATH
TEL.: COMBE DOWN 2355/6

Aero & Jig & Tool Draughtsmen in Great Demand

MEN & YOUTHS

There is an insatiable demand for Aero, Jig and Tools, etc., Draughtsmen and Inspectors. So acute is the present shortage that employers are only too anxious to engage those with no previous practical experience who are able to prepare neat and accurate drawings.

QUALIFY AT HOME—IN SPARE TIME

After brief, intensely interesting study—undertaken at home in your spare time—YOU can secure an attractive and interesting post as **Aero-Draughtsman.** *Numerous vacancies are also available in* **Electrical, Mechanical, Plastics,** *etc., branches of Draughtsmanship.*

FREE GUIDE

The Free Guide contains 132 pages of information of the greatest importance to those seeking such success compelling qualifications as **A.M.I.Mech.E., A.F.R.Ae.S., A.M.I.P.E., A.M.I.M.T., Gen. Cert. of Educ.,** *and* **B.Sc.,** *etc., also* **R.A.F. Entry** *(Maths., etc.), together with particulars of our remarkable guarantee of*

SUCCESS—OR NO FEE

Write now for your copy of this remarkable publication. It may well prove to be the turning point in your career.

NATIONAL INSTITUTE OF ENGINEERING

(Dept. 427), 148-150, HOLBORN, E.C.1
(South Africa: E.C.S.A., P.O. Box 8417, Johannesburg.)

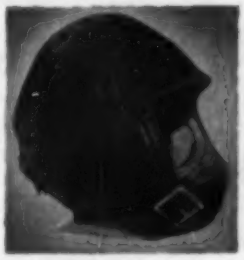
HELICOPTER CHARTER

U.K. and Overseas

AUTAIR LTD.

75 Wigmore Street,
LONDON, W.1.
WELBECK 1131

★ FOR THE CLUB FLYER ★



FLYING HELMET NO. 103

A serviceable helmet specially produced for the club flyer, is ideal for those not requiring electrical intercom. Ear pockets made to take Gosport tubes C/No. 214. Weighs 8 ozs. In brown only. Sizes 6½" to 7½" £1. 15. 0. Gosport tube C/No. 214 18s. 6d.

Terms to Flying Clubs. Trade supplied. Send 3d. in stamps for illustrated catalogue.

D. LEWIS Limited, (Dept. F) 124 Great Portland St., London, W.1.

Tel.: Museum 4314. Grams.: Aviskit, Wesdo, London.

Machinists of plastics for the Aircraft Industry

A.I.D. & A.R.B. APPROVED

Fairleads, Cleats, Panels, Knobs, etc.

E. S. ASTON & CO. LTD.

4 SEBASTIAN STREET

CLERKENWELL, LONDON, E.C.1

Telephone: CLERKENWELL 2179

The . . .

British Air Line Pilots Association

95 MOUNT STREET, W.1

Tel.: GROsvenor 6261

Membership open to all Commercial and Service pilots. For full details concerning objects and particulars of Membership please write to Secretary.

AEROSERVICES LIMITED

WORKSHOP EQUIPMENT available for immediate delivery from our Croydon Stores includes new **PEL ELECTRIC CRACK DETECTOR Mk V,** Demagnetiser, Magneto Test Benches, Sandblasting Cabinets, Valve Refacing Machines and Sparking Plug Cleaner and Tester Units. **ALSO Dakota Spares, C.S.U.s., Generators, J. & H. starters, etc.**

Send list of your requirements to:—

CROYDON AIRPORT, ENGLAND

Tel.: CROydon 9373. *Cables:* Aeroserv, Croydon.

INVERTERS & SPARE PARTS

CLARENCE CARRUTHERS, INC.

79 Wall Street, New York, N.Y.

Exporters-Manufacturers and Dealers

Cable Address: CLARCARRU, N.Y.

AIRCRAFT and ENGINE PARTS

DOUGLAS — LOCKHEED — BEECHCRAFT P & W—WRIGHT—LYCOMING—US RUBBER GOODYEAR—ELECTRONIC PARTS

Immediate attention and prompt shipment

Assure complete satisfaction

ATLANTIC AVIATION

TETERBORO, N.J., U.S.A. Cables: Atlantic Teterboro

A. W. SUTTON & CO., LTD.

GENERAL STAMPERS

FORWARD WORKS, EAGLE STREET, WOLVERHAMPTON

Makers of Upset Forgings for the Rolls-Royce "Avon" engine and others. Drop Forgings for Coal Mines, Motor, Engineering and Shipbuilding Trades. Gas, Steam and Hydraulic Flanges.

AIRCRAFT FOR SALE

R. K. DUNDAS, LTD.

AEROPLANES BY DUNDAS!

AUSTER V. £850.

PROCTOR V. £725 (immaculate).

SEALAND. £12,000 (only 249 hours since new).

AUTOCRAT. £925.

ANSON I. £1,900 (full 12 seater, fully modified).

BONANZA 35, Viking, Tipsy B.

WHITNEY Straight and many other types available.

R. K. DUNDAS, LTD., 29, Bury Street, London, S.W.1. Tel.: WHI. 2848. Cables: "Dundassero, Piccy, London." [0559

AIRCRAFT WANTED

DO you want to sell that aircraft? Then contact us for immediate cash offer. All popular types purchased.

MITCHELL AIRCRAFT, LTD., Airport, Portsmouth. [0349

DAKOTA or Bristol 170 aircraft, fully modified with C. of A. required immediately. Don Everall Aviation, Elmdon Airport. [4553

MILES GEMINI, with or without C. of A. Tozer, Imperial Motors, Exmouth. Phone, Exmouth 2567. [4593

AIRCRAFT ACCESSORIES AND ENGINES

A. J.W. (INSTRUMENTS), LTD.

ALL types of aircraft instruments overhauled. Special test instruments made to your requirements. Particulars on request of our Magnetizer, Demagnetizer and Stroboflash—compact, efficient and inexpensive.

A. J.W. (Instruments) Ltd., Gatwick Airport, Horley, Surrey. Tel. Horley 1420 and 1510 (Ext. 38, 105/6). [0268

90 WRIGHT Continental Engines, ideal for spares or reconditioning.

48 G.E.C. Landing Lights. New.

FURTHER details write: Box No. 8131. [4603

MILITARY and Civil Aircraft and engines spares.—Morris and Horwood, Ltd., 9 Cavendish Square, W.1. Tel. Langham 6467. [0013

AIRCRAFT SPARES & COMPONENTS, 85 Shaftesbury Avenue, London, W.1, have the following for sale:

ENGINES: Pratt & Whitney 985s, Pratt & Whitney 1340s, Pratt & Whitney 1830-92s.

MAGNETOS: SB9-RU3, SB9-RC3, SF14-LU7, SF14-LU8. Pistons Pt. No. 32725. Piston Rings Pt. No. 31406. Rear Pt. No. 165373.

IGNITION Harnesses for 1340 engines: Front Pt. No. 165374. Crankshafts Pt. No. 31732.

GENERATORS Type P.3. Generator Type 0.2. Generators Type KX. Generators wind driven. Fuel Pumps Type F.10. Fuel Pumps AN4101. Booster Pumps and Motors A4949.

GIPSY Engines major overhaul spares.

YOUR further inquiries invited. Telephone GERrard 0575. [0973

VENDAIR of Croydon Airport, suppliers of components and spares for British and American aircraft. Engines in stock include Queen II and III, Lycoming 290, and Cirrus Minor II. Aeroplane spares for Rapide, Proctor, Tiger Moth and Magister. Phone: Croydon 5777. [0603

AIRCRAFT SERVICING

REPAIRS and C. of A. overhaul for all types of aircraft.—Brooklands Aviation, Ltd., Civil Repair Services, Sywell Aerodrome, Northampton. Tel.: Moulton 3218. [0307

AIRCRAFT PROCUREMENT

GROUP CAPTAIN EDWARD MOLE, B.Sc., A.F.R.Ae.S., Aviation Consultant Specialist in the supply or disposal of all types of aircraft and aviation equipment. Quotations obtained upon request—8 Brendon Street, London, W.1. Tel.: PADdington 5406. [0403

CAPACITY AVAILABLE

STARAVIA wish to announce a newly formed section for the design and building of special test rigs covering electrics, hydraulics and instrumentation. *May* we have your enquiries in this connection? We also have capacity available for overhaul of hydraulics, with very prompt delivery. Staravia, Blackbushe Airport, Camberley, Surrey. [460.

A HUNTING-CLAN COMPANY

FIELD'S

World Wide

PRATT & WHITNEY ENGINE

OVERHAUL SERVICE

Sale · Exchange and Overhaul

CONTRACTORS TO

The Ministry of Supply and United States Air Force

A.I.D. & A.R.B. Approved

Details on application to

FIELD AIRCRAFT SERVICE LTD.

CROYDON AIRPORT · CROYDON · SURREY

Phone: CROYDON 7777

Cables: 'FIELDAIR', Croydon

A HUNTING-CLAN COMPANY

129-133

CLOTHING

R.A.F. and R.N. officers' uniforms purchased; large selection of R.A.F. officers' kits for sale, new and reconditioned.—Fishers, Service Outfitters, 86-88 Wellington Street, Woolwich. Tel.: Woolwich 1055. [0567

CLUBS

SURREY Flying Club, Croydon Airport. M.C.A. approved for private pilots' licences. Open seven days a week. Croydon 7744. [0292

HERTS AND ESSEX AERO CLUB, Stapleford Tawney Aerodrome. M.C.A. approved private pilot's licence course. Auster, Gemini, Tiger, Hornet, Messengers and Proctor aircraft. Trial lesson 35/-, 15 miles centre of London. Central Line underground to Theydon Bois, bus 250 to club. Open every day.—Tel. Stapleford 210. [0230

CONSULTANTS

WING COMMANDER R. H. STOCKEN, F.R.Ae.S., Eagle House, 109 Jermyn Street, London, S.W.1. Tel.: Whitehall 8863. [0419

R. K. DUNDAS, LTD., have been giving the correct answers to aviation problems for twenty years. Technical. Purchasing. Operations. Marketing.—29 Bury Street, London, S.W.1. WHI. 2848. [0560

CONTACT LENSES

MODERN CONTACT LENSES CENTRE, 7 (D.1), Bloomsbury Court, W.C.1. Deferred Terms. Booklet sent. [0342

HANGARS

AIRCRAFT HANGARS

T2 Hangar 240 ft. by 120 ft.
T1 Hangar 174 ft. by 96 ft.
Bellman Hangar 175 ft. by 108 ft.
Bellman Hangar 100 ft. by 63 ft.
Blister Hangar 135 ft. by 91 ft.
Blister Hangar 45 ft. by 86 ft.
Romney Hangar 96 ft. by 35 ft.
Framework only or clad to order.
All Ex-Stock.
WESCOL, Queensbury, Bradford. Tel.: Queensbury 2381. [0455

MATERIALS WANTED

AIRCRAFT MATERIALS WANTED

(AID released or commercial) Stainless Steel, and non ferrous metals.
Please send details to
THE MULBERRY CO., Castle Wharf, Orchard Place, London, E.14. Telephone: EAST 4471. [4559

MISCELLANEOUS

ROMNEY BUILDINGS, 96 ft. by 35 ft. by 18 ft., curved building covered new big six asbestos sheets. 1 only. £525. Wescol, Queensbury, Bradford. [0458

TUITION

AIR SERVICE TRAINING

the only fully equipped private School of Aviation. Specialist staff, comprehensive equipment and full residential and recreational facilities within the School ensure the soundest training for an Aviation Career.

M.T.C.A. APPROVED

courses in primary, intermediate and advanced training for pilots, navigators, radio officers and maintenance engineers.

HELICOPTER COURSES

for private and professional licences. Details available from The Commandant.

AIR SERVICE TRAINING, LTD.

Hamble, Southampton. Tel.: Hamble 3001/9. [0970

LEARN to fly for £26. Instructor's licences and instrument flying for £3/5/- per hour. Night flying £4/5/- per hour. Residence 6 gns. weekly. Approved M.C.A. private pilot's licence course. Specialised course for junior commercial pilot's licence. Wiltshire School of Flying, Ltd., Thruxton Aerodrome, nr. Andover, Hants. Tel. Weyhill 352. [0253

TUITION

MINISTRY APPROVED COURSES

for the

COMMERCIAL PILOT AND INSTRUMENT RATING

at the

LONDON SCHOOL OF AIR NAVIGATION

ALL subjects for professional pilot or navigator licences and ratings embracing Academic, Technical, Simulated and Flying aspects. Full-time personal coaching also short periods. Home-study excellent alternative.
33 OVINGDON SQ., KNIGHTSBRIDGE, LONDON, S.W.1. KEN. 8221.
FLYING BASE: CROYDON AIRPORT. [0277

CIVIL Pilot/Navigator Licences.

AVIGATION, LTD., provides full time or intermittent instruction and postal tuition, or a combination of any of these methods to suit individual requirements for the above licences. Instruction can be provided for A.R.B.. General, certain specific types, and A.R.B. Performance schedule examination. Link-training Dept. (City 1162) situated centrally in London. Full briefing for I/R 25/- hr. Block rate (min. 10 hrs.) 22/6 hr.
For full details apply to: The Principal, AVIGATION, LIMITED,
30 Central Chambers, Ealing B/way, London, W.5. Tel.: EALing 8949. [0248

STRESSMEN

NORMALAIR, LTD., YEOVIL

require

STRESSMEN

for work on aircraft refrigeration turbines, and other equipment related to aircraft pressurising and air conditioning. Men without previous stressing experience will be considered, but minimum qualifications are a University degree or H.N.C.

The firm offers well-paid posts with a generous non-contributory pension scheme in an attractive locality.

Applications in the first instance are to be addressed to the

Personnel Manager,
Normalair, Ltd., Yeovil, Somerset

stating age, experience and salary required.

BROOKLANDS AVIATION LTD.

NORTHAMPTON

REQUIRE

AIRFRAME FITTERS

and

INSPECTORS

Preference given to ex R.A.F. and R.N.A.S. Technicians

Regular work with Bonus and Overtime

APPLY TO:

BROOKLANDS AVIATION LTD.
Butlocks Booth, Moulton, Northampton

TUITION

NIGHT Flying, instrument flying, commercial pilot licences. Approved M.T.C.A. private pilot's course.
EVERY facility at reasonable rates from
SOUTHEND - ON - SEA MUNICIPAL AIR CENTRE and FLYING SCHOOL, Municipal Airport, Southend-on-Sea, Rochford 65204. [0452

FREE Brochure giving details of courses in all branches aero eng. covering A.F.R.Ae.S., M.C.A. exams, etc. Also courses for all other branches of engineering.—Write: E.M.I. Institutes, Dept. F 26, London, W.4. (Associated with H.M.V.) [0964

A.F.R.Ae.S., A.R.B.Certs., A.M.I.Mech.E., etc., on "no pass, no fee" terms. Over 95 per cent successes. For details of exams and courses in all branches of aeronautical work, navigation, mechanical eng., write for 144-page handbook free.—B.I.E.T. (Dept. 702), 29 Wright's Lane, London, W.8. [0707

AERONAUTICAL. Comprehensive full-time technical and practical training for careers in all branches of aviation engineering. Diploma course leads to interesting executive appointments in civil aviation design and development, draughtsmanship, maintenance, etc. Extended courses to prepare for A.F.R.Ae.S. and A.M.I.Mech.E. examinations. Write for prospectus to Engineer in Charge, College of Aeronautical Engineering, Chelsea, London, S.W.3. Flaxman 0021. [0019

PACKING AND SHIPPING

R. and J. PARK, LTD., 143-9 Fenchurch St., E.C. Tel.: Mansion House 3082. Official packers and shippers to the aircraft industry. [0012

PHOTOGRAPHY

AIRCRAFT cameras K20, K24, F24, F52, etc. We have large stocks equipment, including controls, mounts, lenses, and processing tanks, film.
HARRINGAY PHOTO SUPPLIES (FM), 423 Green Lane, N.4. MOU. 2054. [0233

PUBLIC ANNOUNCEMENTS

AIR TRANSPORT ADVISORY COUNCIL

THE Air Transport Advisory Council give notice that they have received the undermentioned applications to operate scheduled air services:

APPLICATION No. 43/4. From Airwork, Ltd., of 15, Chesterfield Street, London, W.1, for an Amendment to the terms of approval of their Colonial Coach Service which the Company have been authorized to operate between London and Salisbury (S. Rhodesia) until 31st March, 1956, so as to extend the period of operation from 1st April, 1956, to 31st March, 1957, and to operate the service at a frequency of four return flights per 28 days from April to October inclusive and three return flights per 28 days from November to March inclusive.

APPLICATION No. 18/3. From Hunting-Clan Air Transport, Ltd., of 72, Wigmore Street, London, W.1, for an Amendment to the terms of approval of their Colonial Coach Service between London and Salisbury (S. Rhodesia) similar in all respects to Application No. 43/4 from Airwork, Ltd.

APPLICATION No. 690. From Britavia, Ltd., of 1, Great Cumberland Place, London, W.1, for a Seasonal Inclusive Tour Service to be operated with Hermes aircraft in conjunction with Raymond Cook Travel Guild for the carriage of passengers and supplementary freight between London (Blackbushe) and Basle at a frequency of one return flight weekly, to be operated on Tuesdays or Fridays, during the season from 22nd May to 14th September, 1956.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3, Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained.

WHEN an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [4607

PUBLIC APPOINTMENTS

ROYAL RHODESIAN AIR FORCE

Vacancies for young, single men only, with experience in these trades:
Air signaller (WOP); airframe fitter; instrument fitter, air wireless, ground radio, or radio fitters; safety equipment worker; photographer; clerk G.D.; supplier; electrical fitter; engine fitter; M.T.S. and O.
APPLY, in writing, giving brief details of age and experience, to The Secretary, Rhodesia House, 429, Strand, London, W.C.2. [4588

TWO AERODYNAMICISTS

are required by

GLOSTER AIRCRAFT CO. LTD., GLOUCESTER

ONE TO ASSIST IN

(A) Evaluating stressing assumptions and reducing flight test data related to strength.

AND THE OTHER ON

(B) Performance estimation of development aircraft.

Preference will be given to applicants who are about 26 years of age, with 4-5 years' experience.

Successful applicants will be given some assistance towards securing accommodation or purchasing a house.

Applications should be forwarded to **THE CHIEF DESIGNER.**

MARSHALL

AIRPORT WORKS CAMBRIDGE

have vacancies for

AIRFRAME INSPECTORS
ELECTRICAL INSPECTORS

Modern Houses available for applicants fulfilling specific requirements.

Hostel accommodation for single men.

Long-term employment available on a variety of Multi-Jet and Turbo-Prop, Service and Civilian Aircraft.

Address all applications to
PERSONNEL MANAGER

A. E. P.

(OF HOUNSLOW)

urgently require

STRESSMEN

and

DESIGN DRAUGHTSMEN

for interesting programme of work on aircraft structures and installations.

EXCELLENT CONDITIONS
PENSION SCHEME

AVIATION AND ENGINEERING PROJECTS LTD.
Alexandra Road, Hounslow, Middlesex
Phone: HOUnslow 9621

SAUNDERS-ROE

LIMITED

require

Senior, Intermediate and Junior
DRAUGHTSMEN
STRESS ENGINEERS
AERODYNAMICISTS

and other Technicians at their London, Eastleigh and Osborne, I.o.W. design offices.

Applications will be welcomed from experienced technicians who are keen to join an expanding organisation engaged on interesting and important projects of an advanced nature.

Assistance with accommodation can be given to those selected for work at Osborne.

Interviews may be arranged in London and in other centres.

Please send brief particulars (quoting ref. F/52) to the **Personnel Officer, Saunders-Roe Limited, East Cowes, I.o.W.**

MARSHALL

AIRPORT WORKS CAMBRIDGE

AIRFRAME FITTERS REQUIRED

for long term employment on a variety of multi-jet and turbo-prop aircraft.

Single lodging accommodation available.

★

Address all applications to
EMPLOYMENT OFFICER

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order 1952.

AVIATION INSTRUMENT DEVELOPMENT

KELVIN & HUGHES LIMITED have vacancies in the Research and Development Department of their Basingstoke Works for a number of Development Engineers and Senior Engineers for work on the development of aircraft instruments and similar projects.

APPLICANTS for the senior posts should have a 1st or 2nd class honours degree in mechanical or electrical engineering or physics, or the equivalent, and have had experience in the design and development of small mechanisms, or in the design of small motors, simple servo systems and amplifiers, as appropriate. The positions carry responsibility and involve leading a small team of development engineers.

THE minimum qualifications for Development Engineers are Intermediate B.Sc., or appropriate Higher National Certificates, with preferably some experience in the development of small mechanisms, or in light electrical work.

FOR all posts, some experience of aircraft instruments would be an advantage, but is not essential. The work is of an interesting nature and carried out in well equipped laboratories within easy reach of London.

REMUNERATION will be commensurate with qualifications and experience. A superannuation scheme is available.

APPLY giving full details of qualifications, experience, etc., to the Chief Engineer (Aviation Instruments), Kelvin & Hughes, Ltd., Winchester Road, Basingstoke, Hants. [4564

BRITISH OVERSEAS AIRWAYS CORPORATION

have vacancies for

AIRCRAFT DRAUGHTSMEN

at London Airport. An interesting programme embraces preparation of design drawings for the development and research modifications and repair, etc., on Corporation Aircraft. Experience in airframe or aircraft engines design and education up to Ordinary National certificate standard. Applicants with experience in other forms of engineering would be considered. Salary in accordance with A.E.S.D. rates of pay, based on age and experience, plus proficiency pay scheme. Normal working hours 37½ (5-day week). Attractive Pension, Insurance, Sickness and Leave entitlement schemes. Catering facilities. First class Sports and Social activities. Applications in first instance to Asst. Staff Manager (Appointments), B.O.A.C. London Airport, Hounslow, Middlesex. Hounslow 7777—Ext. 2359. [4602

BRITISH EUROPEAN AIRWAYS

require

ENGINEERS

for the maintenance, overhaul and development of

ELECTRONIC FLIGHT SIMULATORS

APPLICANTS should possess a sound basic knowledge of electronics and have experience in positional and rate servos, accurate repeater mechanism, etc. Salary on probation £635 p.a. increasing to £679 p.a. after approximately six months, rising to £775 p.a. maximum in grade. Additional payments for shifts. Written applications to Personnel Officer, Flight Operations Department, B.E.A., Keyline House, Ruislip, Middlesex. [4604

THE ENGLISH ELECTRIC COMPANY LIMITED

AIRCRAFT DIVISION

Aircraft Materials Development Laboratory

ENGINEERS and metallurgists with degree or H.N.C. are required for a number of interesting vacancies in this laboratory to work on the development of new types of construction for structural use in high speed aircraft. The work covers the evaluation of ferrous and non ferrous materials, the development of forming and jointing techniques and the application of new types of materials. A considerable expansion of this laboratory is planned in conjunction with the company's research and development in advanced high speed aircraft.

APPLY, giving full details, to Department C.P.S., 336/7, Strand, W.C.2, quoting Ref. L.2. [4596

ELECTRICAL Engineer with 'X' licence required for the overhaul of Dove, Heron and Dakota equipment.

PERMANENT position with prospects offered.

APPLY to Chief Engineer, Cambrian Airways Ltd., Cardiff Airport, Nr. Barry, Glamorgan. Tel.: Barry 2100. [4598

SITUATIONS VACANT

A. V. ROE & CO., LTD.

have the following vacancies:—

1. Senior Trials Team Leaders possessing good qualifications and experience in applied electronics and aircraft/G.W. field trials.
2. Senior Development Test Site and Magazine Engineer with extensive experience of explosives and Safety equipment.

GOOD salaries and prospects. Pension scheme.

APPLICATIONS should be addressed to:—

The Chief Engineer,
Weapons Research Division,
A. V. Roe & Co., Ltd., Woodford, Cheshire.
[4557

THE COLLEGE OF AERONAUTICS

VACANCIES exist in the Department of Aircraft Propulsion for Designer Draughtsmen, one in Section Leader capacity, for interesting work on the design of rigs, instrumentation, and plant associated with the testing of all forms of aircraft propulsion units (including rocket motors) and auxiliaries. H.N.C. or equivalent preferred. Five-day week. Four weeks' leave a year, excluding Bank Holidays. Staff pension scheme. Salary according to age, qualifications and experience. Applications giving full particulars should be addressed to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks. [4597

JERSEY AIRLINES

INVITE applications from pilots holding senior commercial or A.L.T.P licences, to fill vacancies in their Heron and Rapide flights. Applicants should not be more than thirty years of age, and have at least 1,800 hours flying experience, of which a large proportion should be in command of multi-engined aircraft. A small number of pilots with lower qualifications may be considered for initial employment on Rapide aircraft. Applications should be made in writing to the Chief Pilot, Jersey Airlines, States of Jersey Airport, Jersey, C.I. [4605

TECHNICAL Writer required for compiling servicing manuals, general instructional literature and copy writing. Must have the highest technical qualifications. Apply, The Secretary, Martin-Baker Aircraft Co., Ltd., Higher Denham, nr. Uxbridge, Middlesex. Tele.: Denham 2214. [4581

The Chief Designer of Saunders-Roe Limited extends his best wishes for a Happy Christmas and Prosperous New Year

to all Draughtsmen, Engineers and Technicians who contemplate joining his team in the near future

SARO

EAST COWES • ISLE OF WIGHT

SITUATIONS VACANT

THE ENGLISH ELECTRIC COMPANY LIMITED AIRCRAFT DIVISION

A RADIO Engineer with a knowledge of aircraft applications is required for the Flight Test Department for the development of installations of navigational and radar systems. This appointment offers a post of responsibility for a suitably qualified man at the company's aircraft design and research organization at Warton, near Lytham St. Annes, Lancs.

APPLY, giving full details, to Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. No. F.1. [4595

VICKERS-ARMSTRONGS (AIRCRAFT), LTD., have vacancies for:

DESIGN Draughtsmen preferably with aircraft experience but men with mechanical, structural or electrical design experience also considered. Write giving full particulars including age and salary required to:

PERSONNEL Department, Hursley Park, nr. Winchester. [4575

"C" Licensed Engineer with Group 6.1 endorsement or would consider Cirrus Minor endorsement. House for married man.

BLACKPOOL AND FYLDE AERO CLUB, LTD., Blackpool Airport. [4604

AERO ENGINES. A company manufacturing gas turbine engines has the following vacancies for Mechanical Engineers.

FOUR positions in the Main Engine Development Department. Applicants must have a Degree or H.N.C. Salary range £600-£800 dependent on qualifications and experience. Two positions in the Defect Investigations Department. Salary range £750-£900 dependent on experience.

INSURANCE and superannuation schemes together with excellent welfare considerations. Application quoting MEX/D1, Technical Personnel Officer, Box 7398. [4442

TEST and Laboratory Engineers required for gyro and electro mechanical instruments. Apply stating age, experience and salary required to S. G. Brown, Ltd., Shakespeare Street, Watford, Herts. [0147

A FLIGHT Engineer required for C-47/DC3 aircraft operated by Oil Company Sumatra. Salary £160 per month plus board and lodging on two year successive agreements with local and home leaves. Not over 35 with over 5 years' experience with A. and C. Flight Engineer licence endorsed P & W Twin Wasp R 1830-92 and R-2000 engines. Apply in writing with full particulars quoting "SUM" to Caltex Services Limited, Thames House (Entrance 3), Millbank, London, S.W.1. [4571

DESIGNERS! DRAUGHTSMEN! STRESSMEN!

HUNTING PERCIVAL AIRCRAFT LTD.

have opened a

DESIGN OFFICE at

18, CAVENDISH SQUARE, LONDON, W.1.

These premises provide magnificent working conditions, and are situated within a minute of the Oxford St. bus services and 3 minutes from Oxford Circus Underground Station.

We require:

SENIOR AND INTERMEDIATE DESIGN DRAUGHTSMEN with Structural, Mechanical or Electrical experience.

SENIOR AND JUNIOR STRESSMEN who have obtained Engineering Degree, H.N.C. or similar qualification.

THESE POSITIONS ARE PERMANENT WITH VERY GOOD PROMOTION PROSPECTS AND THE WORK COVERS A VERY INTERESTING AND EXTENSIVE PROGRAMME OF DEVELOPMENT ON CIVIL AND MILITARY FIXED AND ROTATING WING AIRCRAFT, AND OTHER HIGH PRIORITY PROJECTS.

Good salaries will be paid to the right men and we are prepared to pay for experience and qualification. Contributory Pension and Life Assurance Scheme. Assisted Luncheon Scheme.

PLEASE APPLY, GIVING FULL PARTICULARS OF AGE, EXPERIENCE AND QUALIFICATIONS TO:—

THE PERSONNEL MANAGER

HUNTING PERCIVAL AIRCRAFT LTD. LUTON AIRPORT BEDS

FLIGHT SIMULATION

A SENIOR DEVELOPMENT ENGINEER

is required by

THE RESEARCH DEPARTMENT

of

SHORT BROS. & HARLAND LIMITED

to head a team engaged on the development of the computing and servo systems for an advanced type of aircraft flight simulator.

Applicants should possess a University Degree in Electrical Engineering or Physics, preferably with honours, and have had considerable experience of analogue computing techniques, either electronic or electro-mechanical, or of simulation.

This post, which is permanent and pensionable, offers an excellent opportunity for a man with initiative and ability to join a rapidly expanding and well-equipped organisation. The interview can be arranged in London or Belfast, and assistance with housing and removal is available.

Write, stating age, qualifications and salary required to Staff Appointments Officer, P.O. Box 241, Belfast, quoting S.A.118.

Bristol

Interesting vacancies in the

TECHNICAL PUBLICATIONS SECTION

of

THE BRISTOL AEROPLANE COMPANY LIMITED

The Company urgently requires one TECHNICAL AUTHOR for work on electrics and two TECHNICAL ILLUSTRATORS, one for work on fixed wing aircraft and one for work on helicopters.

Applications are also invited from

EXPERIENCED PUNCHED CARD MACHINE OPERATORS

for employment in the Mathematical Services Group at Filton. Successful applicants will be required to carry out work under supervision involving the use of key-punch, verifier, sorter, reproducer and tabulator.

Applicants should have reached G.C.E. standard in Maths and Physics and have an aptitude for technical work. Previous experience on Hollerith or I.B.M. equipment is essential. Successful applicants will be given the opportunity of being trained in the operation of electric and electronic calculating machines.

Write, giving details and QUOTING DO/JF.54 to:

The Personnel Manager, The Bristol Aeroplane Company Limited, Filton House, Filton, Bristol

Applicants for the vacancies in the Technical Publications Section should QUOTE DO/JF.55.

SITUATIONS VACANT

CHIEF Engineer, preferably A, B, C, X licences, small and medium types, required to develop overhaul/maintenance base, Midlands. Reply in confidence. Box No. 8075. [4587

SABRE Test Pilot, experience on other type of aircraft of great value, current flying practice, 1,000 hrs. PPL with R/T and I. rating. Responsible man capable of working on his own.

APPLICATIONS to Chief Test Pilot, Airwork Ltd., Gatwick Airport, Horley, Surrey. Tel.: Horley 1551. [4591

AIRCRAFT radio engineers required for Southend and Newcastle airports. Apply Chief Radio Engineer, B.K.S. Engineering Limited, Southend Airport, Essex. [4594

GRADUATE with hons. mathematical degree 1st or 2nd class, for senior position with small team carrying out pure research work and problems connected with equipment for Gas Turbine Engines.

THIS vacancy is pensionable and offers an opportunity to progress to senior appointments in a new and rapidly expanding Company. Applications should be made to the Personnel Manager, Joseph Lucas (Gas Turbine Equipment), Ltd., Shaftmour Lane, Hall Green, Birmingham, 28. [4599

ENGINE and airframe fitters with experience on light and medium types required for expanding aircraft repair organisation. Also vacancies for young improvers wishing to gain experience for engineers' licences. Box No. 7839. [4529

ONE captain and two first officers with Dakota and Rapide endorsement required by Manx Airlines Limited. Full B.A.L.P.A. rates and income tax 4/6. Reply Chief Pilot, Manx Airlines Limited, Ronaldsway Airport, Isle of Man. [4592

AIRCRAFT Inspectors required for Details, Major Assemblies, Final Erection and Flight Shed work. Good pay and prospects for suitable men. Apply stating age and particulars of experience to: Personnel Officer, Hawker Aircraft (Blackpool), Ltd., South Shore, Blackpool. [4565

RATEFIXERS required for Aircraft Details and Assemblies. Applicants must have a good engineering background and be experienced Ratefixers. Good salaries and working conditions. Pension scheme. Apply in confidence to: Personnel Officer, Hawker Aircraft (Blackpool), Ltd., South Shore, Blackpool. [4566

SMITHS AIRCRAFT INSTRUMENTS, LIMITED have the following vacancies in their engineering laboratories at Bishop's Cleeve, Cheltenham:

1. Electrical engineer to work on the design and development of small precision A.C. motors and tachogenerators. Previous experience on fractional h.p. or miniature machines desirable. *Ref.* 64 EN/1.
2. Electrical engineer to work on the design and development of moving coil instrument mechanisms. Previous experience in the making, assembly and testing of such mechanisms would be an advantage. *Ref.* 64 EN/2.
3. Electronic circuit engineer for the development of test equipment to suit research and production requirements. Applicants should have a degree in electrical engineering or physics. Previous experience in measurement techniques and the design and development of electronic instruments in the frequency range 0 to 100 Kc/s is essential. *Ref.* 64 EN/3.
4. Engineer to specialise in the mechanical design of electrical and electronic equipment containing magnetic amplifiers and transistor circuitry. Previous experience essential. Applicant will be required to evolve techniques for miniaturization and subassembly construction together with problems connected with vibration and climatic proofing for airborne equipment. *Ref.* 64 EN/4.
5. Senior engineer for circuit development of equipment employing small electro-magnetic transductor and electronic sub-assemblies. Applicants must have a degree or equivalent qualifications and at least three years laboratory experience. *Ref.* 64 EN/5.
6. Graduate engineer as assistant to senior engineer in development of circuitry for transistor servo amplifiers. *Ref.* 64 EN/6.

THE positions are permanent and carry generous salaries commensurate with experience and qualifications. A pension scheme is available.

APPLICATIONS with full details of qualifications and experience and salary required and quoting the above references should be made to Personnel Manager, Smiths Aircraft Instruments Limited, Bishop's Cleeve, Near Cheltenham. [4609

WANTED, DRAUGHTSMEN to design in aluminium for sales development. Must possess Higher National Certificate in Mechanical Engineering. Location Banbury. Good working conditions and pleasant surroundings. Attractive starting salaries offered up to £800 p.a. with prospects of promotion from drawing board. Pension plan in operation. Send brief details of qualifications and experience to Northern Aluminium Co., Ltd., Bush House, Aldwych, London, W.2. [0348

AN attractive opportunity exists for a limited number of young men to obtain valuable training in the drawing office of a Company specialising in Aircraft Hydraulic Systems and Controls. The company has available comprehensive educational facilities, and having wide interests in the automotive and general industries, offers an unusual scope in its particular field. Men who have recently completed their national service, or who are nearing release, are in particular invited to write giving an outline of their experience and activities to the Personnel Officer, Lockheed Hydraulic Brake Co., Ltd., Leamington Spa, Warwickshire. [4577

CANADAIR

LIMITED

MONTREAL

needs

SENIOR PROJECT DESIGNERS

Requires a B.Sc. or H.N.C., plus apprenticeship and considerable experience in the technical aspects of modern aircraft design and the application of this experience and creative ability to the conception of new projects.

SENIOR AERODYNAMICISTS

Requires a B.Sc. or H.N.C., plus apprenticeship and a minimum of six years' experience in development of methods of analysis, project airloads analysis, performance prediction, and stability and control.

CANADAIR OFFERS

An expanding, long-term programme of design development in Montreal, providing excellent and permanent opportunities for several senior project designers and aerodynamicists with recent experience in project design. The programme will include the development of new and diversified aircraft projects and full scope will be given to the project designer and aerodynamicist in the application of his experience and creative ability.

★ Excellent salaries based on qualifications.

★ Liberal moving and settling allowances.

★ Excellent pension and insurance schemes.

Please send details of qualifications to:

J. H. DAVIS,
European Representative,
CANADAIR LIMITED,
PRINCES HOUSE,
190, PICCADILLY, LONDON, W.1.

SITUATIONS VACANT

CAMBRIAN AIRWAYS, LTD., Rhoose Airport, require pilots for Dakota, Heron and Dove operation. Minimum qualifications: senior commercial licence and instrument rating. Apply to Chief Pilot. [4589

DEVELOPMENT engineers and technicians required in research department of a well-known firm of precision engineers, particularly for work in connection with servo systems, small precision motors, and gyroscope instruments. Apply stating age, experience and salary required to S. G. Brown, Ltd., Shakespeare Street, Watford, Herts. [0146

VACANCIES will occur early in the New Year for engineers having licences for Dakota/Dove and their engines, to be based in the Middle East. Long term appointments, good salary and allowances, gratuity on completion of contract. Fullest details in confidence to Airwork Ltd., Overseas Division, Sutton Lane, Langley, Bucks. [4590

TO Regular Service Personnel in the Engineering Branches of the R.N.A.S. and R.A.F. Fully trained skilled tradesmen of all categories who are shortly anticipating release and keen to enter civil aviation are invited to write to British European Airways. We shall be pleased to send full details of employment at London Airport. Inquiries will be welcomed by the Personnel Officer, Engineering Base, B.E.A., London Airport, Hounslow, Middlesex. (Please quote B/3.) [4502

SENIOR and Intermediate Draughtsmen with aircraft and mechanical engineering experience required. The work will interest men who can apply their design ability to the development of new equipment which has a steadily growing application. Pleasant working conditions. Pension scheme. House purchase assistance considered. Within easy reach of Bournemouth. Special transport facilities. Apply in writing to Personnel Manager, Flight Refuelling Limited, Tarrant Rushton Airfield, nr. Blandford, Dorset. [4533

AIR Traffic Control Officer required by large British Oil Company for service in the Persian Gulf. Pilot or ex-pilot preferred, must hold Ministry of Civil Aviation Control Licence endorsed for aerodrome approach and flight information or its equivalent and have had 5 years' experience on airfield control. Bachelor under 35 preferred. Pensionable service, paid home leave, total emoluments not less than £1,650. Write quoting No. 573 to Box No. 9438, c/o Charles Barker and Sons, Ltd., 31, Budge Row, London, E.C.4. [4606

BOOKS, ETC., WANTED

ALL classes aviation books bought, sold and exchanged. Send 2½d. for new 9 page List No. 6 Beaumont, 59 Russell Road, Perry Hill, Enfield, Middx. [4650

ANY Aviation books and photos wanted, especially Janes, 1914-18 narratives, 1939-45 recognition booklets and magazines. Send for free list of highest cash prices paid. Aeroplane Book Supply (Dept. 7), 28 St. Andrew's Gardens, Toronto, 5, Canada. [4225

MARSHALL

AIRPORT WORKS CAMBRIDGE

DESIGN AND DRAWING OFFICE

Modification, Trial Installation, and Development Work

Including radar and electronic installations on

MULTI-JET & TURBO-PROP AIRCRAFT

SENIOR DRAUGHTSMEN

INTERMEDIATE DRAUGHTSMEN

STRESSMEN

WEIGHTS ENGINEER

TECHNICAL AUTHORS (Electrical)

TECHNICAL AUTHORS (Radar and Radio)

MODERN OFFICES AND EQUIPMENT

ASSISTANCE GIVEN WITH HOUSING

EXCELLENT SALARIES AND PROSPECTS

Applications, with full details, including dates available for interview to:—

PERSONNEL MANAGER

JOSEPH LUCAS LIMITED

BURNLEY

Manufacturers of Aircraft & Motor Equipment

Require men of proved ability to fill responsible posts as

PRODUCT ENGINEERS

These well paid positions offer to capable, ambitious men an excellent chance of further promotion. Applicants must possess a sound knowledge of gas turbine combustion equipment and aircraft standards. The possession of a Higher National Certificate would be an advantage. A generous pension scheme is in operation. Full restaurant services are provided.

Apply by letter to the

PERSONNEL MANAGER, HARGHER CLOUGH WORKS

HAWKER AIRCRAFT LIMITED

KINGSTON-ON-THAMES SURREY

TECHNICAL STAFF

UNIVERSITY GRADUATES AND STUDENTS

Applications invited from men with Degrees or expecting Degrees this year in Aeronautical, Mechanical or Civil Engineering, or Electrical Engineering, Physics or Mathematics.

The company offers:

(1) POST-GRADUATE TRAINING IN PRODUCTION ENGINEERING;

(2) POST-GRADUATE TRAINING IN DESIGN RESEARCH;

(3) EMPLOYMENT in Design, Research and Development and Experimental work.

Enquiries should be made irrespective of National Service liability. Brochures and forms obtainable from Colleges, Secretaries of University Appointments Boards or the Company.

DESIGN DRAUGHTSMEN
Juniors, Intermediate and Seniors.
Mechanical and Electrical.

TECHNICIANS
Design and Research.

STRESSMEN

SENIOR JIG AND TOOL DRAUGHTSMEN

SENIOR METHODS ENGINEERS

TECHNICAL CLERKS

JUNIOR FEMALE MATHEMATICIANS

AIRCRAFT INSPECTORS
Flight and Electrical
(Dunsfold Aerodrome).

Attractive commencing salaries will be arranged according to qualifications, experience and age. Superannuation. *Please write fully to:-*

The Personnel Supervisor, HAWKER AIRCRAFT LTD.
CANBURY PARK ROAD, KINGSTON-ON-THAMES, SURREY

GLOSTER AIRCRAFT CO. LTD.

GLOUCESTER

HAVE VACANCIES ON SUPER-PRIORITY DESIGN AND DEVELOPMENT PROJECTS

FOR

AIRCRAFT DESIGN DRAUGHTSMEN

(SENIOR & JUNIOR)

Consideration will also be given to Draughtsmen with Mechanical, Structural or Electrical Experience.

Also

STRESSMEN

(SENIOR & INTERMEDIATE)

for both strength and flutter calculations.

The conditions of employment are good with progressive salary, good sports and welfare facilities, pension scheme, etc.

APPLICATIONS STATING AGE, PREVIOUS EXPERIENCE AND EMPLOYERS SHOULD BE ADDRESSED TO THE

CHIEF DESIGNER

BOOKS, ETC.

"CELESTIAL Navigation for Yachtsmen," 2nd Edition. By M. Blewitt. This little book, intended especially for beginners, should receive a very warm welcome from every yachtsman who has wanted to learn the art of navigation by the heavenly bodies, but has been deterred by its apparent complexity. In particular, it will make an immediate appeal to all who feel their mathematics are not up to standard, for neither geometry nor trigonometry play any part in the authors' explanation—indeed, even those who can manage little more than addition and subtraction should master this book with ease! 62 pages. Illustrated 5s. 3d. from all booksellers, or Iliffe & Sons, Ltd., Dorset House, Stamford St., London, S.E.1.

"PLASTICS Progress: Papers and Discussions at British Plastics Convention 1953." The complete text and illustration of the papers (given by 29 experts) together with a full report of the discussion. Subjects include: unplasticized p.v.c.; plastics material developments; reinforced plastics; durability and performance of plastics in service; problems in injection moulding; economics of large mouldings; new uses in industry—cables, metallization, footwear and conveyor belting. 50s. net from all booksellers. By post 51s. 6d. from Iliffe & Sons, Ltd., Dorset House, Stamford St., London, S.E.1.

SIR GEORGE GODFREY & PARTNERS LIMITED

of

HAMPTON ROAD WEST, HANWORTH, MIDDLESEX

invite application for the following vacancies for work in connection with aircraft pressurisation and allied subjects.

RESEARCH GROUP

ENGINEERS of B.Sc. standard preferably with experience of thermo and gas dynamic studies to join a Research Group investigating problems of heat flow in supersonic aircraft. This work forms part of a systematic study which will extend over a period of years.

ELECTRONIC ENGINEER who should possess a degree in electrical engineering or suitable experience of instrument technology.

Apply to the Personnel Officer giving full details of experience, other qualifications, age and salary required. The vacancies are pensionable and train fares for applicants outside the London area will be paid if required to attend for interview.

HUNTING PERCIVAL AIRCRAFT LTD.

require a

SENIOR DESIGN ENGINEER

in their Helicopter Department to design and develop Ducting Systems for High Temperature Gases.

Experience in this field essential and some knowledge of Gas Dynamics would be an advantage. Good Welfare facilities, including Staff Pension Scheme.

Applications in writing to the

Personnel Manager,
Hunting Percival Aircraft Ltd.
Luton Airport, Beds.

stating age, experience and salary required.

COTTON BAGS
FOR SPARE PARTS, ETC.
WALTER H. FELTHAM & SON, LTD.
Imperial Works, Tower Bridge Road,
Telephone: HOP 1784 LONDON S.E.1

AIRCRAFT SPRING WASHERS

TO B.S. SPECIFICATION S.P.47
CROSS MFG. CO. (1938) LTD., COMBE DOWN, BATH

R.A.F OFFICERS
UNIFORMS
LARGE SELECTION IN STOCK
NEW AND RECONDITIONED
FISHERS, 86/88 WELLINGTON ST.
WOOLWICH, S.E.18 'PHONE 1055

Coley Metals Group
R. J. COLEY & SON
(HOUNSLOW) LTD.
CHAPEL ROAD HOUNSLOW
MIDDLESEX. Hounslow 2266
METALFUL · PHONE HOUNSLOW
Metal Merchants
Branches
KINGSTON
HOUNSLOW
BRISTOL
SWINDON
PRESTON
R. J. COLEY & SON
(NORTHERN) LTD.
KING ST. DUKINFIELD
CHESHIRE
Phone: ASHTON-U-LYNE 3644

The most exciting collection of pictures ever presented

There is just time to get it for Xmas!
PHOTOGRAMS
Of the Year 1956
An outstanding collection of the world's finest photographs, printed in warm-toned photogravure, letterpress for the high-key photographs, and full colour. A plate-by-plate commentary and articles of interest to all photographers complete this magnificent annual. You must have PHOTOGRAMS 1956. Get your copy NOW!
10¼" × 8¼" 152 pp.
17s. 6d. net
By Post 18s. 2d.
From booksellers, photographic dealer or from:—
Published for "Amateur Photographer"
Iliffe & Sons Limited · Dorset House · Stamford St. · London, S.E.1

INDEX TO ADVERTISERS

	Page
Aeroservices, Ltd.	53
Armstrong Whitworth Aircraft, Ltd., Sir W. G.	22
Aston and Co., Ltd., H. B.	53
Atlantic Aviation, Inc.	53
Autair, Ltd.	52
"Aviation Magazine"	20
Aviation Traders, Ltd.	46
Aviation and Engineering Projects, Ltd.	55
Bolton Gate Co., Ltd.	18
Boulton Paul Aircraft, Ltd.	11
Bramah and Co., Ltd., J. R.	15
Briggs Motor Bodies, Ltd.	39
Bristol Aeroplane Co., Ltd., The	57, Cover iv
British Air Line Pilots Association, Ltd., The	53
British European Airways	26
British Messier, Ltd.	45
British Thomson-Houston Co., Ltd., The	16
Brooklands Aviation, Ltd.	54
Bryans Aeroquipment, Ltd.	47
Burnley Aircraft Products, Ltd.	6
Canadair, Ltd.	58
Carlisle and Co., Ltd., C. G.	13
Carruthers, Inc., Clarence	53
Central Office of Information (R.A.F.)	32, 33
Clifford Products, Ltd.	36
Coley and Son (Hounslow), Ltd., R. J.	60
Cross Manufacturing Co. (1938), Ltd.	52, 60
De Havilland Engine Co., Ltd., The	9
Dowty Equipment, Ltd.	40
English Electric Co., Ltd., The	27
E.R.S., Ltd.	50
Esso Petroleum Co., Ltd.	41
Fairey Aviation Co., Ltd., The	29
Feltham and Son, Ltd., Walter H.	60
Ferranti, Ltd.	19
Field Aircraft Service, Ltd.	53
Firth-Vickers Stainless Steels, Ltd.	Cover iii
Fishers	60
Flight Refuelling, Ltd.	43
General Electric Co., Ltd., The	49
Gloster Aircraft Co., Ltd.	58, 59
Godfrey and Partners, Ltd., Sir George	59
Graviner Manufacturing Co., Ltd.	20
Hadfields, Ltd.	10
Hawker Aircraft, Ltd.	50
H & P Precise Castings, Ltd.	12
Hughes-Johnson Stampings, Ltd., The	14
Hunting Percival Aircraft, Ltd.	37, 56, 59
Iliffe and Sons, Ltd.	50, 60
Jessop and Sons, Ltd., William	35
Kelvin and Hughes (Aviation), Ltd.	Cover ii
Kontak Manufacturing Co., Ltd.	46
Lewis, Ltd., D.	53
Leytonstone Jig and Tool Co., Ltd.	18
Lucas (Gas Turbine Equipment), Ltd., Joseph	24
Lucas, Ltd., Joseph	58
Marconi, Ltd.	47
Marshall's Flying School, Ltd.	55, 58
Martin-Baker Aircraft, Ltd.	30
National Institute of Engineering	52
Normalair, Ltd.	54
Plessey Co., Ltd., The	23
Polarcold, Ltd.	46
Portway Forgings (Wednesbury), Ltd.	51
Powis and Sons, Ltd., David	48
Precision Rubbers, Ltd.	14
Pyrene Co., Ltd., The	17
Redifon, Ltd.	42
Robinson and Sons (Willenhall), Ltd., Arthur	12
Rolls-Royce, Ltd.	25
Rozalex, Ltd.	52
Rubery Owen and Co., Ltd.	48
Sangamo Weston, Ltd.	44
Saunders Valve Co., Ltd.	16
Saunders-Roe, Ltd.	34, 55, 56
Shell Mex and B.P., Ltd.	21, 31
Short Brothers and Harland, Ltd.	7, 57
Skyhi, Ltd.	51
Smith and Son, W. H.	48
State Express Cigarettes	8
Steel and Co., J. M.	51
Sutton and Co., Ltd., A. W.	53
Teddington Aircraft Controls, Ltd.	44
Terry and Sons, Ltd., Herbert	1
Turner Brothers Asbestos Co., Ltd.	49
United Aircraft Export Corporation	2, 3
Vernons Industries, Ltd.	4
Vickers-Armstrongs (Aircraft), Ltd.	5
Wakefield and Co., Ltd., C. C.	28
Westland Aircraft, Ltd.	Cover i
Wiggin and Co., Ltd., Henry	38
Yorkshire Engineering Supplies, Ltd.	50

Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1, by SUN PRINTERS LTD., London, and Watford, Herts. *Flight* can be obtained abroad from the following: AUSTRALIA AND NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service, Ltd.; Gordon & Gotch, Ltd. SOUTH AFRICA: Central News Agency, Ltd.; Wm. Dawson & Sons (S.A.), Ltd. UNITED STATES: The International News Co. Entered as Second Class Matter at the New York, U.S.A., Post Office.

For some time research has been directed towards the development of the lost wax process for producing precision castings in stainless and heat-resisting steels. To-day we are able to offer regular and quantitative production and from the wide selection of our special steels are able to meet a variety of service conditions. Precision castings have opened up new fields for design engineers who find them the solution to many difficult production problems.

Our precision castings are being used today in aircraft, textile plant, hospital equipment, in refrigerators and cameras. Details and technical literature will be sent on request.

FIRTH-VICKERS STAINLESS STEELS LTD SHEFFIELD

Telephone: Sheffield 42051

FLIGHT
16 December, 1955

Britannia

ROUND THE WORLD PERFORMANCE

STAGE from / to	LONDON / KARACHI	KARACHI / SINGAPORE	SINGAPORE / SYDNEY	SYDNEY / FIJI	FIJI / HONOLULU	HONOLULU / SAN FRANCISCO	SAN FRANCISCO / NEW YORK	NEW YORK / LONDON
STAGE DISTANCE st mi	3940	2947	3916	1970	3180	2395	2580	3444
SCHEDULE TIME hr min	10.41	8.00	10.56	5.14	9.38	6.28	6.26	9.17
BLOCK SPEED m p h	368.5	368.8	357.9	376.7	330.2	370.1	401.4	370.8
PAYLOAD lb	28,000	28,000	27,353	28,000	28,000	28,000	28,000	28,000

These route analysis data have been computed to airline reserves and allowances

THE BRISTOL AEROPLANE COMPANY LIMITED ENGLAND

Projection by permission of John Bartholomew & Son Ltd